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THE UNIVERSITY OF HONG KONG

AN EMPIRICAL ANALYSIS OF THE IMPACT OF IMPROVEMENT OF PUBLIC TRASNPORTATION ON THE PRIVATE RESIDENTIAL PROPERTY PRICE – A STUDY OF THE MA ON SHAN RAIL

A DISSERTATION SUBMITTED TO
THE FACULTY OF ARCHITECTURE
IN CANDIDACY FOR THE DEGREE OF
BACHELOR OF SCIENCE IN SURVEYING

DEPARTMENT OF REAL ESTATE AND CONSTRCUTION

BY

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HONG KONG
APRIL 2006

Declaration

I declare that this dissertation represents my own work, expect where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed : _____

Name : _____

Date : _____

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Abstract

The improvement of public transport carries lots of impact on real estate market. One of the impacts of the improvement of public transport on residential property market is the change of property price. Literature shows that the improvement of public transport brings about the positive effect on the property price.

This dissertation is to investigate the effects of Ma On Shan Rail on the private residential developments nearby. The effects are examined in three stages – announcement stage, construction stage and operation stage.

The result shows that there is a decline of price gradient between City One and Ma On Shan linking up by the Ma On Shan Rail, indicating the preference of people in purchasing residential properties changes over the three periods. It also shows that the proximity to station increases the property price, indicating the preference of better accessibility and convenience.

The empirical results provide a reference to Government, developers and homebuyers in dealing with the matters related to planning purpose, marketing strategy and selection of residential developments.

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Chapter 1 Introduction

1.1 Introduction

Hong Kong has an outstanding public transport system, high private transport costs and a high density of population. All factors that go towards explaining why the number of passenger journeys in 2004 exceeds 11 millions per day as shown in Table 1.

	1999	2003	2004
Franchised bus	3,961	4,047	4,081
KCRC Light Rail Transit Feeder Bus	60	71	55
Mass Transit Railway	2,164	2,130	2,299
Red Minibus and Green Minibus	1,586	1,631	1,706
Taxi	967	975	1,030
KCR - Heavy Rail	757	767	934
Tram	250	232	243
KCR - Light Rail	314	291	360
Ferry	157	146	155
Residents' services	115	174	178
Total	**10,330**	**10,465**	**11,042**
*in thousands			

Table 1: Public transport: average daily number of passenger journeys

(Source: Transport Department, 2005)

However, with the limited availability of land and high cost of road construction, the Government has acknowledged that the growth in private car ownership is not wholly welcomed. Therefore, to relieve the pressure from the rise of car ownership and environmental consideration, Environment, Transport and Works Bureau [1] has five 'better' focuses:

1. Better integration of transport and planning of land use
2. Better use of railways as the back-bone of the passenger transport system
3. Better public transport services and facilities
4. Better use of advanced technologies in transport management
5. Better environmental protection

Within the five 'betters', four of them are related to the rail network. According to the Railway Development Strategy 2000 (Transport Bureau, 2000), once the rail network is increased by the intended amount, 70% of the population of Hong Kong will live and 80% of jobs will be located within one kilometer of a railway station. The aim is to increase rail's share of public transport to 45% of journeys by 2016[2].

[1] http://www.etwb.gov.hk/press_releases_and_publications/publications/aheadnew/index.aspx?langno=1&nodeid=850

[2] rail's share of public transport in 2004 is 33% of journeys (Table 1)

1.2 Aim and objective of the study

As rail network takes an important role in public transportation, the change of the railway network will give rise to extensive impact on various sectors in Hong Kong. The change in the demand for residential properties within the region connected by the railway may have impact on the price gradient. The decline of price gradient may be due to the growth of the demand of housing in sub-urban areas and the improvement of transportation networks. On the other hand, it is possible for the price gradient to increase due to the adverse environmental impacts caused by the increase of population density in the new town areas. In this study, Ma On Shan Rail will be the subject to be studied. Ma On Shan Rail passes through and provides service to Ma On Shan, which is dominated by residential sector.

Therefore, the aim of this study is to investigate the impact brought by Ma On Shan Rail on residential property. It is an important topic to be studied because the result of this study can provide empirical evidence to show the impacts of the railway lines on the residential property market. Hence, it can provide a reference for the Government and the railway companies in implementing the plans on the arrangement on the transportation network to suit the future needs of society. Besides, the result also provides a direction for the developer in determining the location of the development, time of the construction and the selling price of the property in order to obtain maximum profit. For the homebuyer, the result gives them a reference in determining the investment or housing in reasonable price.

Several aspects are available to be analyzed in the residential sector. Out of these aspects, property price is chosen as the main determinant to observe the impacts of the railway on residential developments because such impacts are reflected in the property price. In addition of other attributes, such impacts can be easily to observe through the analysis.

The price is examined through the comparison of distance from the Central Business Center and distance from the station. As Ma On Shan Rail was announced to be constructed in 1999 and came into operation in 2004, the impact within this period will be studied in three main phases, which are announcement period, construction period and operation period.

Therefore, the objectives of this study are:

1. to investigate the change of price gradient of private residential developments along Ma On Shan Rail during announcement period, construction period and operation period

2. to investigate the effect of proximity to a station on the private residential developments along Ma On Shan Rail during announcement period, construction period and operation period

1.3 Hypothesis

Construction work of a railway, such as Ma On Shan Rail, usually takes several years. However, people's preference is changing and the expectation from the improvement of transportation on choosing property is turned up even earlier in announcement period. It is because people realize the impact on price of residential property starting from the construction is officially gazetted and announced.

Hence, when considering two areas, one is more distant away from the center than the other, and both are lying on the railway, then it is thought that there will be an increase in price level in both areas and the price level in the remote areas will be increased in higher rate, due to the decrease of transportation cost and traveling time to the center in comparing with nearer area.

Moreover, the distance between the residential developments and the station impacts on the property price. It is believed that the station serves as a center. The property price decreases when distance from station increases, forming the negative gradient.

Throughout the period of announcement, construction and operation, it is supposed that the impacts will be exaggerated. The price gradient will be less and less negative, and the difference of prices of property, due to the increase of distance from the station, will increase.

Therefore, in this study, the hypotheses to be tested are:

1. The improvement of public transportation will lead to a decline in the price gradient for areas linking by the railway in the periods of announcement, construction and operation.

2. The proximity to the station increases residential property prices in the periods of announcement, construction and operation.

First is to find the residential price gradient in City One and Ma On Shan in three periods. One is announcement period, representing the period between the date of construction of Ma On Shan Rail gazetted and the date of construction commenced. Then it is construction period, subject to period between date of commencement of construction and date of operation of railway. The last one is operation period, indicating the period after the railway comes into operation. The first hypothesis is correct if it is found that the price gradient is declined between two places.

Second is to find the change of property price level in City One and Ma On Shan due to the proximity to a station. It is tested through three different time periods and the variance among these periods is compared. The second hypothesis is correct if the rate of the decrease of property price increases in three different periods.

1.4 The structure of the study

The study is divided into the following chapters:

1. Chapter 1 – Introduction

   The brief background of public transportation in Hong Kong, the objectives of the study and the hypotheses to be tested are delivered.

2. Chapter 2 – Background of rail network

   The background of the change of rail network in Hong Kong, the Kowloon-Canton Railway Corporation, and Ma On Shan Rail is reviewed.

3. Chapter 3 – Literature review

   Past literatures from numerous writers regarding land use and rent, and the research about the use of hedonic pricing analysis for improvement of public transportation are examined.

4. Chapter 4 – Methodology

   The research methodology, about the model used and variables included, and the scope of study, including the area included, selection of developments and period of study, is discussed.

5. Chapter 5 - Empirical result, analysis and discussion

   The result is analyzed and the hypotheses are tested.

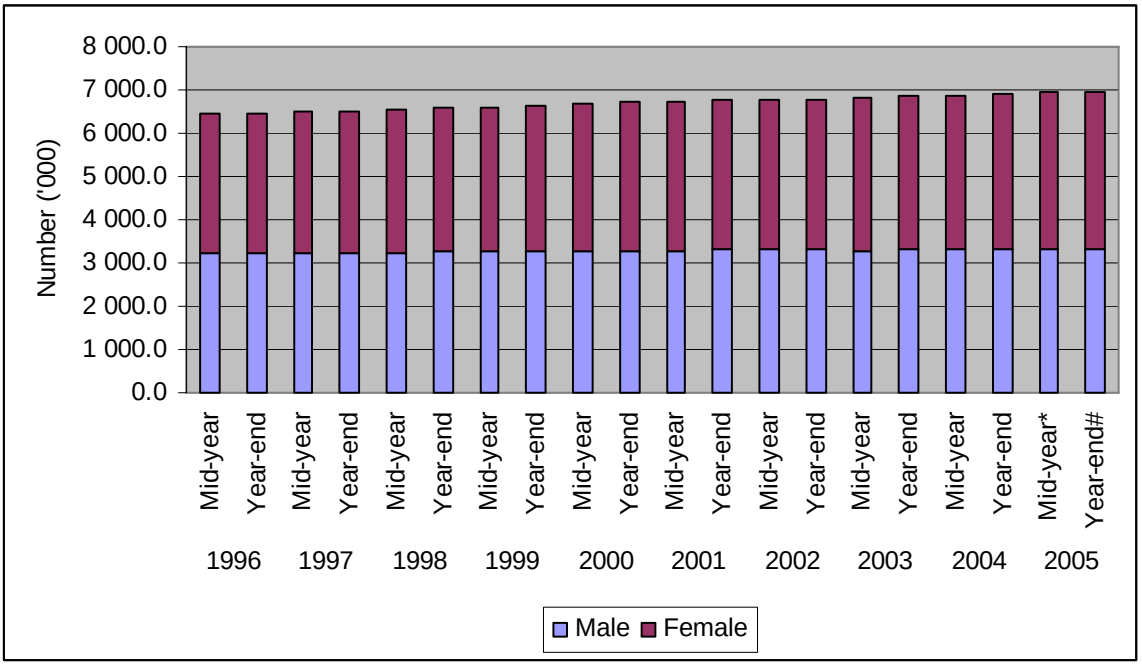
6. Chapter 6 - Conclusions

   Conclusions, limitations of the study and recommendations are drawn.

Chapter 2 Background

Introduction

Hong Kong is one of the most densely populated cities in the world, with population density of abut 6,300 persons per square kilometer in 2005. Figure 1 shows the population in Hong Kong by sex, in which the population at the end of 2005 is estimated at 6,970,800.



Notes: * *Revised figures*

\# *Provisional figures*

Figure 1: Population by sex in Hong Kong

(Source: Census and Statistics Department, 2006)

Rapid growth in population increases the demand for housing greatly. Since there is insufficient supply of land in urban areas, migration of population is necessary to move part of people to the new town areas. Thus the scheme to develop new towns in the New Territories resumes. According to Census and Statistics Department in 2005, there is total 3.5 millions of population living in new towns, in which they believe to enjoy various community and recreational facilities. The increasing population to move and live in new towns increases the burden of the reliance on public transportation. Hence, the Government has to expand and to improve the transport infrastructure to provide additional connections between new towns and urban areas. This results in the invention of “Railway Development Strategy 2000”.

2.2 Target area to study

Shatin new town consists of the areas of Shatin and Ma On Shan. It covers approximately 60-kilometer with the growth of population from 30,000 in 1970s to 640,000 at present. In 2011, it is expected the population will grow to 800,000, due to the higher accessibility attributable to Ma On Shan Rail, which serves the area of Ma On Shan and Shatin in the East New Territories since 2004.

The completion of Ma On Shan Rail will shorten the traveling time between Ma On Shan, Shatin and urban areas, making commuting easier and less expensive. It helps to shift the people from densely populated urban areas to sub-urban areas.

Ma On Shan District

Ma On Shan locates at the coastal area of Tolo Harbour. This area began to be developed in 1979 as the extension of Shatin new town. After Ma On Shan Railway came into operation at the end of 2004, it is forecasted that the population will increase to 430,000. Upon the prediction, Ma On Shan has a very high potential to be developed. In last decade, there were several private developments constructed in Ma On Shan, including Sunshine City, Ma On Shan Center, Villa Athena, Bayshore Towers, The Watersides, Vista Paradiso, Valla Oceania, Monte Vista, Ocean View, Mountain Shore and Marbella. All these developments have the common selling points that the properties are located near to the shore with better feeling of spacious than urban area, better view of the ocean and sky, modern entertainment facilities and convenient transportation.

2.3 Rail network in Hong Kong

When a railway is fully utilized, it will provide an environmental friendly public transport with low cost, high reliability, convenience, high level of safety and comfort. In considering reliability, speed and environmental impact, railway is better than road transport. However, higher cost of construction is the disadvantage in fully utilizing railway in a city. In economic view, it is feasible only if there is sufficient demand of railway so that the average cost of provision of service is acceptable by public. Therefore, it is difficult to fulfill the requirement for the full coverage of rail network in city such as Hong Kong.

The railways in Hong Kong accounts for about 30 per cent of daily domestic passenger travel and about 70 per cent of land based cross-boundary trips to the Mainland in 2005. On the same time, a great problem is encountered due to an increase of population and continuous development in Hong Kong. To maintain the success and improve the efficiency of rail network in Hong Kong, the Government focuses on sustainable development. Thus, planning and implementation of the expansion and improvement of transport infrastructure, especially rail network, is emphasized. Consequently, the Government has formulated the Railway Development Strategy 2000 which provides the outline of the development of rail network in order to meet the increasing transport needs in sustainable manner for next two decades.

Existing rail network in Hong Kong

In Hong Kong, the existing rail network consists of 10 railways. Island Line, Kwun Tong Line, Tseun Way Line, Tseung Kwan O Line, Tung Chung Line, Airport Express Line and Disneyland Resort Line which are operated by the Mass Transit Railway Corporation Limited (MTRCL), and East Rail, West Rail and Ma On Shan Rail which are operated by the Kowloon-Canton Railway Corporation (KCRC)[5]. Figure 2 shows the existing rail network in Hong Kong.

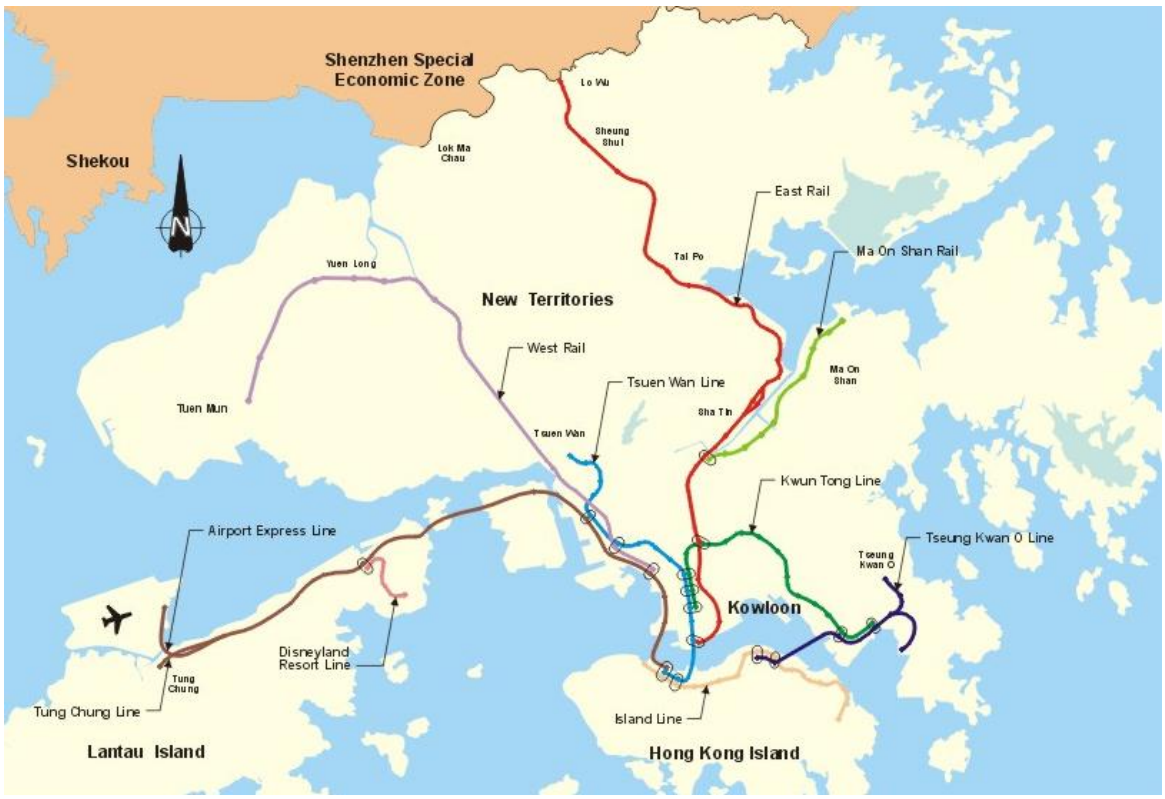


Figure 2: Existing rail network in Hong Kong

(Source: Highways Department, 2006)

[5] Light Rail Transit is also organized by KCRC

As the rail is used as the back-bone of public transportation, the rail network is now under the extension to cover majority area in Hong Kong.

Railway projects

There are two extensions which are currently carried out. One is Sheung Shui to Lok Ma Chau Spur Line. This 7.4-kilometer long, under constructed railway aims to provide a second railway to the Mainland to meet the increasing cross boundary demand and relieve the congestion at Lo Wu, which handles in excess of 85 million passengers. It is planned to come into operation in mid-2007.

Another railway is Kowloon Southern Link, 4.5-kilometer long railway which extends the West Rail to connect the East Rail at East Tsim Sha Tsui. Upon completion, passengers will be able to travel from the East Rail to the West Rail, or vice versa. It is expected that the railway will operate in the period of 2008 to 2009.

Figure 3 shows the map of committed railway projects and Table 2 shows the information of committed railway projects.

Figure 3: Committed railway projects

(Source: Highways Department, 2006)

Project	Scheduled completion date
Sheung Shui to Lok Ma Chau Spur Line	2007
Kowloon Southern Link	2009

Table 2: Information of committed railway projects

Railway projects under planning

There are total six railway projects under the planning stage. The Shatin to Central Link will form a new rail corridor from the new town to the Central Business Area (CBD) through the Fourth Rail Harbour Crossing. The comprehensive implementation programme will depend on further study on the feasibility and the planning development along the railway line.

The Northern Link will link West Rail to East Rail and also the boundary crossing point at Lok Ma Chau. The completion of project will provide rail services and boundary services to the North New Territories.

The construction of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link is expected to decrease the time of travel between Guangzhou and Hong Kong from the existing more than one and a half hour to about an hour. Also through the future Beijing-Guangzhou Passenger Line, an opportunity is provided for the access to Mainland cities.

Rail extension from the existing Hong Kong Island Line forms the West Hong Kong Island Line and South Hong Kong Island Line, providing rail service to part of Southern Hong Kong Island South and West.

The Port Rail Line provides a rail connection from Lo Wu to Kwai Chung in order to make the direct transport of freight available between Mainland and container ports at Kwai Chung. The provision of railway will bring about the growth of rail-based cross boundary traffic.

The North Hong Kong Island Line provides the extension of Tung Chung Line along the northern part of Hong Kong Island.

Figure 4 shows the map of railway projects under planning in Hong Kong and Table 3 shows the information of planning projects.

Figure 4: Railway projects under planning

(Source: Highways Department, 2006)

Project	Estimated completion date
Shatin to Central Link	2008 - 2011
Northern Link	2011 - 2016
Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link	Under review
West Hong Kong Island Line/ South Hong Kong Island Line	Under review
Port Rail Line	Under review
North Hong Kong Island Line	beyond 2016

Table 3: Information of railway projects under planning

2.4 Ma On Shan Rail

As mentioned before, Ma On Shan Rail is organized by Kowloon-Canton Railway Corporation which is owned by the Government.

History of Kowloon-Canton Railway Corporation (KCRC)

In 1980's, to strengthen Hong Kong to be the major port to China, Kowloon-Canton Railway was planned and run by the British Government. After the Qing Government permitted the construction of railway between Hong Kong and Canton in 1895, it was governed by local Governments to construct and manage. The one managed by the British Government is called East Rail, built in 1910, along which there were nine stations from Tsim Sha Tsui to Lo Wu in single track. It did not only carry passengers or goods between two places, it also carried the food from Mainland to Hong Kong.

The significant improvement of KCR started at 1973. After the observation of the introduction of diesel electric train in 1950s could not cope with the existence of new town and the rapid growth of population, double track was implemented in 1973 and electrification of trains was completely finished in 1983. Therefore, fully equipped railway having the whole journey with 35-kilometer long provided a fast and convenient services between sub-urban area and Kowloon.

In 1982, with the enactment of the Kowloon-Canton Railway Corporation Ordinance (Cap 372), the KCRC became a statutory body entirely held by the Government to manage according to 'prudent commercial principles'. Therefore, apart from East Rail,

the KCRC developed several rail systems in Hong Kong. In 1988, the Light Rail Transit (LRT) was operated to serve the West and Northwest New Territories linking Tuen Mun and Yuen Long. In 2003, West Rail opened to provide service between West Kowloon and the Northwest New Territories, linking with LRT. At the end of 2004, extension of the East Rail to Tsim Sha Tsui was finished and Ma On Shan Rail commenced to provide service to Ma On Shan District.

In future, the Lok Ma Chau Spur Line linking Sheung Shui and Lok Ma Chau will be put in the service in 2007. Other rails are now under planning such as the Shatin-Central Link, Kowloon Southern Link and Lok Ma Chau Spur Line. The Figure 5 shows the rail network under the KCRC.

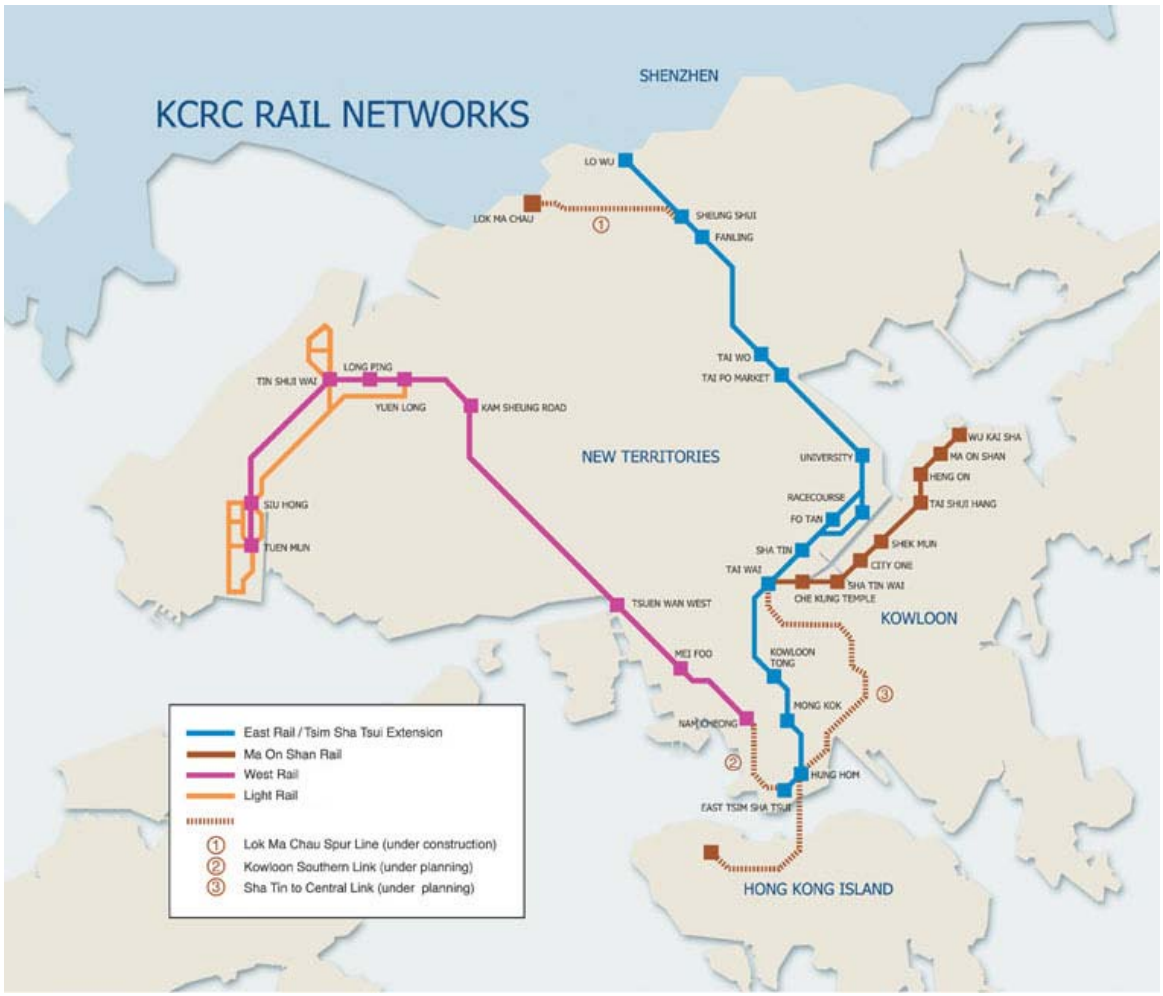


Figure 5: Route map of KCRC

(Source: KCRC, 2006)

Background of Ma On Shan Rail

In 21st December 2006, Ma On Shan Rail commenced to operate and serve the public. Tracing to the past, the idea of Ma On Shan Rail was already shaped up since 1960s.

In early 1960, the British Government was trying to carry out the development of new towns to solve the overcrowding problem in urban areas. One of the new towns is Shatin. However, there were two problems in developing Shatin new town. First problem came to

the rail service. In 1960s, the trains were operated by the diesel engine, resulting in high commuting time from Shatin to Kowloon. Second, the rail station was located at the west of Shing Mun River, far away from central residential area. Therefore, there was a suggestion of the provision of railway for the area in the east of Shing Mun River.

In 1967, Freeman, Fox, Wilbur Smith & Associates issued Hong Kong Mass Transport Study about the suggestion of construction of rail network in Hong Kong, including the one linking between Shatin and East Kowloon. It is the preliminary version of Ma On Shan Rail. However, the proposal was objected in 1970 after issuing Hong Kong Mass Transit Further Studies. The Studies stated that the population in Shatin would not be under the expected growth, resulting in elimination of the proposal.

In early 1970, Shatin new town expanded continuously, especially in Yuen Chau Kok where City One was built in 1980s. Thus, the plan of railway linking for Shatin new town revived. In 1976, Hong Kong Comprehensive Transport Study disagreed with the report in 1969 that it was necessary to provide modern and fast rail line to East Shatin area. The Study also recommended the electrification of rail of KCRC.

In 1980s, the development of New Town Plaza made the Shatin Station of East Rail became the center of Shatin District. The successful development rendered the development of railway along East Shatin area to stop. However, while Ma On Shan new town was developing, some pieces of land were reserved for KCRC to implement the construction of railway, becoming Ma On Shan Rail at the present.

In 1989, Hong Kong Second Comprehensive Transport Study proposed Ma On Shan Light Rail Line linking Tai Wai and Ma On Shan. However, it was criticized that it was not feasible to construct the Light Rail Line in the financial view of getting low return.

The Railway Development Study and the Railway Development Strategy issued in 1993 and 1994 respectively stated the planning of Ma On Shan Rail. To cope with the development of new towns in East New Territories, the importance of Ma On Shan Rail was recognized in Third Comprehensive Transport Study in 1999. In the same year, the construction project of Ma On Shan Rail is officially announced. In 2001, the construction of railway commenced. The construction was finished and came into operation in 2004.

Ma On Shan Rail, 11.4-kilometer long railway, has total nine stations staring from Wu Kai Sha to Tai Wai, linking with East Rail as shown in Figure 6.

Figure 6: Ma On Shan Rail

(Source: Highway Department, 2006)

Chapter 3 Literature Review

3.1 Introduction

Consideration of the relationship between the location of urban land uses and rent began in earnest at the beginning of the nineteenth century. In this chapter, studies on relationships between urban location and rent, agglomeration theory and the hedonic pricing model transportation are reviewed.

3.2 Theories on urban location and rent

3.2.1 Ricardo's theory

Ricardo (1817) presents a treatment of agricultural rent which serves as the basis for most existing theories. Ricardo's concept of rent is confined to the use of the indestructible power of the soil. He recognizes that rent varies with the fertility and situation of land. He points out that the most fertile lands are used first, followed by less favored land while the demand for agricultural products increases. As farmers compete with each other for the most productive land, this competition benefits the landlords who take the full advantage in form of rent, which is higher in the more productive land that possesses an advantage over less productive lands. He also recognizes that the relationship between rent and the distance from the market, as land which is nearer the market bears lower transport costs on its produce than more distant land. This advantage is reflected in higher rent. According to Ricardo, theory of rent contains three major principles. First, the more

useful grades of land are first utilized, and with the growth of population the movement is from the better to the less useful land with increasing rents on the older lands

3.2.2 Von Thünen's Theory

Von Thünen (1826) develops the agricultural location theory, deriving from the situation rent of the various crops which can be grown around an isolated town. Given some basic assumptions[7], three factors interact with each other to determine the location of each agricultural land use. They are price at the market, cost of production and transportation cost as shown in Figure 7. He works out that the rent each crop can bid at each location will be the savings in transportation of its product that the site affords in contrast with a more distant site. Those producers closer to the center than the most distant producers will enjoy the same market price, but they will not spend as much on transportation costs. For any one crop, a rent gradient can be calculated which will reveal maximum rent at the town. The rent will decline because one moves away from the town to reflect the increased burden of transportation costs. The most distant land in cultivation yields no savings in transportation and there will be no rent at that location. In other words, the rent at any location is equal to the difference of the value of its product, and their costs including production costs and transportation costs.

[7] The assumptions are as follows:

1. The city is located centrally within an 'Isolated State' which is self sufficient and has no external influence
2. The Isolated State is surrounded by an unoccupied wilderness.
3. The land of the State is completely flat and has no rivers or mountains to interrupt the terrain
4. The soil quality and climate are consistent throughout the State.
5. Farmers in the Isolated State transport their own goods to market via oxcart, across land, directly to the central city. Therefore, there are no roads.
6. Farmers act to maximize profits

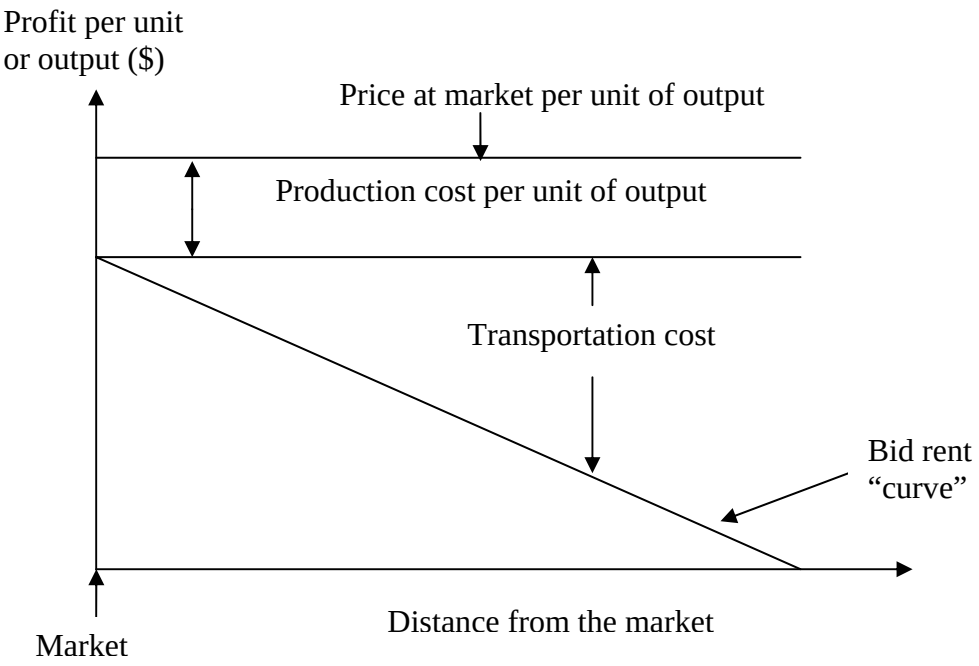


Figure 7: Von Thünen's agricultural location model

(Source: Von Thünen, 1826)

Besides, Von Thünen also investigates the relationship of the economic forces affecting land rent and agricultural price, to the pattern of land use. His analysis is established on the assumption that the geographical pattern of agricultural production is directly related to the competition among alternative uses, such as timber and livestock, for a single plot of land and the use that deserves the highest rent determined land use at that location.

Distance from the central market is the key factors of land use. Land near the city will be used for the most intensive agricultural purpose such as dairying and garden vegetables. As distance increases from the center, transportation costs increase and land rents decrease because only less intensive uses could be supported. Von Thünen constructs concentric rings around the city center, each dominated by a distinct economic activity. The concentric ring is shown in Figure 8.

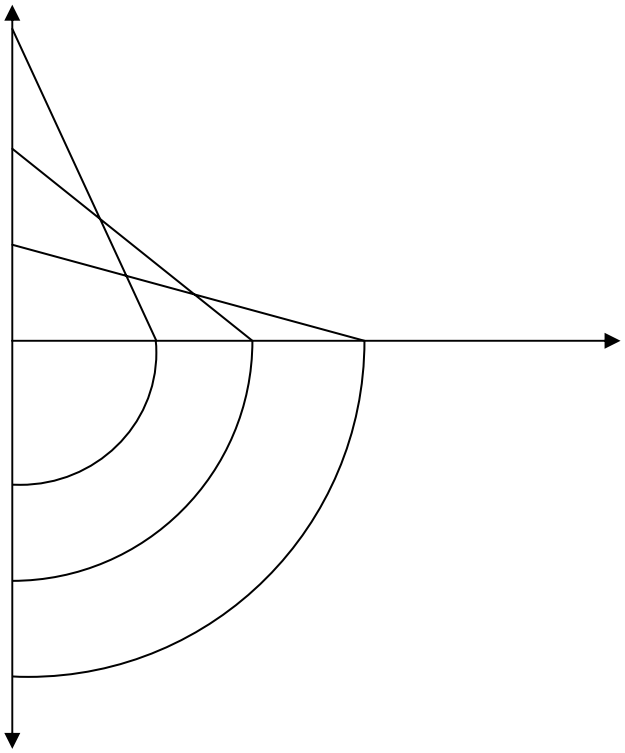


Figure 8: Von Thünen's concentric ring

(Source: Von Thünen, 1826)

3.2.3 Hurd's theory

Up to twentieth century, Hurd had the similar ideas with former writers. Hurd (1903) develops a comprehensive synthesis of the economic theory of urban land values. He applies the theory of economic competition among farmers for agricultural land to businesses in an urban area. He attempts to describe the causes of different land values within an urban area and suggests that as value depends on economics rent, and rent on location and location on convenience, and convenience in nearness, the intermediate steps can be eliminated and so value depends on nearness.

Hurd agrees that economic rent for urban sites is based on superiority of location. With future forecast, the mastering factor of all exchange values and capitalization rates will tend to change with the prospects for growth in different localities. Generally it is lower in larger cities where the ease of sale and stability of property income are greater. He further points out that urban land values are affected by general financial and economic conditions that values at times represent simply a condition of the public mind. He recognizes that the complexity of the influence of transportation improvements on urban land values in his discussion railroad development on urban values.

> *"street railroads have wrought a revolution in the structure of cities, scattering population over a wide area, adding value to the circumstance by rendering it accessible for residences, and to the center by concentration traffic within it, a part of this added value being removed from the intermediate zone. By rendering new districts accessible, this increasing the area of supply of land, the value of all competitive land is reduced, so that the effect of street railroads, on residence land is to lower its average value."* (Hurd 1903, pg. 242)

3.2.4 Haig's theory

Haig tries to sharpen the analysis of the effect of location on land value by thinking of the relative accessibility advantages of different urban sites. With the assumptions[8], Haig (1926) summarizes that the center of the city has the advantages of physical proximity or accessibility to all parts of the city. All activities will locate its business in the center,

[8] Haig assumes that an isolated city in which accessibility to the center is the dominant aim. He also assumes that the main objective of individuals and businesses in making locational decisions is to reduce the sum of site rentals and transportation costs (which he refers to as the costs of frictions) to a minimum.

which is the most convenient point, for location and rents in that sector will therefore be the highest. Competition of uses will bring about exclusion of certain uses which place a lower rental value on central location. The owners of the relatively accessible sites will impose a rental charge equal to the saving in transportation costs which the use of their sites makes possible. He highlights the relationship between rent and transport costs, the latter being the payment to overcome the 'friction of space': the better the transportation network, the less the friction of space. The ideal site for an activity is that which offers the desired degree of accessibility at the lowest costs of friction. Haig's hypothesis was "…the layout of a metropolis…tends to be determined by principle which may be termed the minimizing of the costs of friction." His hypothesis focuses on the cost side of profit maximization. Some land uses are able to obtain a revenue-generating advantage from certain sites, especially those most accessible to customers. As a result, the revenue-generating potential of a site must be weighed against the costs of friction for these land uses.

Haig (1927) further points out that general improvements in transportation or particular developments which make it easier or cheaper to get to or from the center of the city will decrease the relative accessibility advantages of central sites and hence decreases total urban site rents and values. On the contrary, reduced accessibility from outlaying areas will drive businesses and individuals to move in closer to the center and tend to raise site rents and values.

3.2.5 Weber's theory

Weber's theory (1929) is restricted to the incorporated processes of the manufacturing and marketing of distinct products. The factors deciding the location of such processes, including disintegrated processes and processes through which various products area produced mutually, are considered as the exclusive advantages of cost in that location. Weber, in his theory, only considers the advantages of cost which have impact on all industries and do not rely on the characteristics of economic system. Therefore, Weber imagines the changes of cost due to the changing of location of manufacturing processes.

In the theory, there are three sets of cost which varies with the changing of locality. These costs are cost of transportation, cost of raw material and fuel, and cost of labour. To make things simpler, cost of raw material or fuel is included in the cost of transportation. Therefore, higher price of the raw material or fuel is regarded as the more expensive source located further from possible industry location. Therefore, two costs are taken into consideration, and these are cost of transportation and cost of labour.

It is assumed that there are fixed place of consumption and fixed centers of suitable labour. In focusing on the transportation cost, it affects the local distribution of manufacturing industries because these industries will be located at points with the lowest transportation cost. In Weber's model, he first chooses the location of sources of raw materials and fuel involving the lowest transaction cost, forming the locational figure which is a triangle, quadrangle or a more complex figure, comprising the consuming point and the sources of raw materials to be used. Beside, it involves the decision of the point at which there is the lowest transportation cost with regard to the locational figure,

either at the consuming point, at one of the sources of raw materials or fuel, or at the point amid. The point will be the location of the manufacturing process.

Weber works out the transportation cost regarding the weights transported and the distance covered. All other factors relating the transportation cost are converted into weight or distance, which are computed from variation of actual weights and distances. Hence, the locational figure is determined by the lowest ton-miles. Each corner of the figure, including the consuming point and all sources of raw material and fuel, draws the manufacturing process with different forces. For examples, the consuming point exerts a pulling force on the weight of the end products while sources of raw material and fuel exert a pulling force on the weight of its material.

The strength of the pulling forces from the consuming point or sources of raw material or fuel depends on the characteristics of the material used, which can be converted into end products without any loss of weight, or varying reduction of weight. Material with reduction of weight when converting into end product is called weight-losing materials, which attract the manufacturing process as the weight of the end products is lower than the weight of the material. Nevertheless, not only the localized raw materials are to be taken into account, but also those raw materials that are to be found everywhere. These materials are called ubiquitous materials, which do not involve in the formation of the locational figure, but they are one of the factors to determine the location of manufacturing process between the consumption point and the sources of localized raw materials. The weight of the end products is not only made up by the weight of the localized materials including into the weight of the end products, but also by the weight of the ubiquitous materials. Therefore, the location of manufacturing process depends on

the amount of weight-losing materials relative to the amount of ubiquitous materials inputting the weight of the end product.

As a second factor of location, Weber introduces the differences of cost of labour in different places. The preferred centers of labour are considered as attracting the industries from the points of lowest transportation cost to points having lower labour cost and higher transportation cost. The industrial process moves from a point with the lowest transportation cost to point with lower labour cost if the saving in labour cost is larger than the additional transportation cost. Weber then locates the point of lowest transportation cost in figures with the lines linking the points with equal additional transportation cost, as isodapane. Among them, there is one isodapane linking the points, at which the additional transportation cost just offsets the saving of labour cost, as cirtical isodapane. If the preferred labour place is situated within the critical isodapane, it diverts the manufacturing process, otherwise the manufacturing process stays at the point with lower transportation cost.

Except two main factors determining the location of industries, Weber introduces group of factors with different nature, which is regarded as agglomerating factors and deglomerating factors. These factors will be discussed later in ***3.3.4 - Weber's agglomeration theory***.

3.2.6 Ratcliff's theory

Ratcliff (1949) sticks to classical rent theory in holding that the value of urban land services derives in the major part from location and that the value differences among sites

are reflection of differential locational advantages. He disagrees that value is the capitalized expression of economic rent and that market prices of land will tend to reflect prediction concerning its future productivity. The business calculations that determine urban land usage are basically similar to those employed in other fields of investment and the term "highest and best use" simply describes the type of land development program for a specific site which will adjust the highest payment for land.

Ratcliff criticizes Haig in explaining the manner in which transportation costs affect site rents and values. Ratcliff appears to recognize elements of potential error in Haig's broad generalizations about the adverse influence or general transportation improvements on site rents and values.

> *"…improvements in transportation which benefit only one area will, of course, result in higher rents in that area."* (Ratcliff 1949, pg. 372)

Haig hypothesizes a "magic carpet" type of transportation improvement in which it will be easier for everybody to go everywhere. Ratcliff states that since transportation facilities always go from one place to another, it is difficult to understand how transportation improvements can avoid increasing the accessibility of these specific areas and hence site rents and values.

3.2.7 Lösch's theory

Lösch (1954) presents his ideas through a set of simple equations with a highly simplified static model of a space-economy operating under conditions of monopolistic competition.

With several assumptions[9], if there is a person finds it profitable, due to the economies of large-scale production as opposed to the disadvantage of transportation cost, to produce a commodity over and above the needs of his homestead, his market area will suppose to be a circular form. However, if one farmer finds it profitable to produce over and above his needs, so will others. This force of competition, by eliminating all excess profits, not only will catch the market area of the original producer, but also will transform the circular shape of market area into hexagon. The hexagon is the ideal economic form of market area. Firstly, a net of hexagonal market forms will completely cover any area under consideration, while circular ones will leave empty and unutilized corners. Secondly, of all the polygons which will completely cover a given area, the hexagon differs least from the circle form, reduces the transport costs in supplying a given demand, and maximizes the demand of the population of a given area.

For each commodity, the plain is divided into a honeycomb, which is a net of hexagon, of market areas. Lösch then groups these honeycombs according to the size of their respective market units, and, in the way compatible with the established criterion of minimum transport effort, he orders the resulting nets about a common, central production point to obtain his system of nets.

[9] (1) a broad, homogenous plain with uniform transport features in all directions and with an even scatter of industrial raw materials in sufficient quantity for production.
(2) a uniform distribution of agricultural population with a uniform set of tastes and preferences, each homestead at the start being self-sufficient.
(3) technical knowledge disseminated throughout the plain and production opportunities available to all.
(4) extra-economic forces are excluded.

3.2.8 Alonso's theory

Alonso (1964) extends the von Thünen model to urban land uses. His model gives land use, rent, intensity of land use, population and employment as a function of distance to the CBD of the city as a solution of an economic equilibrium for the market for space. He develops bid-rent model[10] which is a set of combinations of land prices and distances among which the individual is indifferent. It shows the land rent the household could pay at each distance in order to achieve a predetermined utility level. As the individual considers residential locations at different locations in the city, i.e. at increasing distances from the city center, what price of land would allow him/her to buy sufficient amount of land and other goods to enjoy as much satisfaction as a given price and amount of land at the city center.

Figure 9 shows the set of price for land the individual could pay at various distances while deriving a constant level of satisfaction. It describes how rent declines with distance from the CBD which is called the bid rent function and illustrates how the value of land reflects its accessibility to the CBD.

[10] There are several assumptions applied to the model:
1. City is located on a featureless plain which only consists of CBD in where all the job located and surrounding ring where contains all residence
2. All households have identical utility functions, live in identical houses and identical income to spend on housing rentals, commuting cost and consumption goods (assumed to be identical , so that there will be negative correlation of rent and commuting cost)

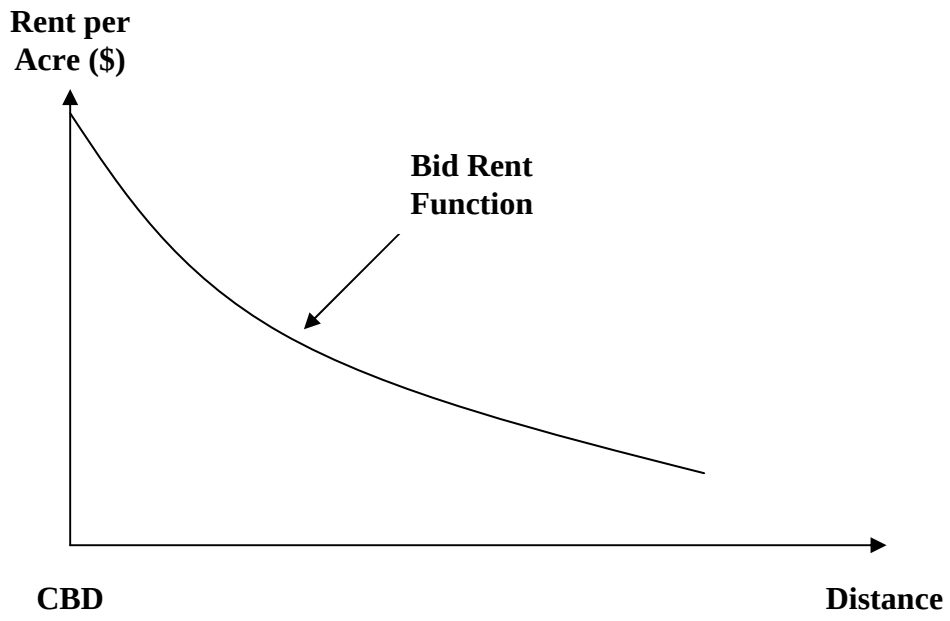


Figure 9: Alonso's bid rent function

(Source: Alonso, 1964)

Generally, the bid-rent function can be applied to agricultural land, business and housing. In agricultural rent model, Alonso concludes that for each potential user of land, a family of bid rent functions is derived such that the user is indifferent as to his location along any one of these functions. For example, there are two crops' bid rent functions shown in Figure 11. The farmer of crop 2 is willing to pay more in the area between the CBD and distance t_i, while the farmer of crop 1 is willing to pay more in the area at distances greater than t_i. It denotes that the rents in fact are paid as WXY. Therefore, it comes to second conclusion that equilibrium price at any location is found by comparing the bids of the potential users and choosing the highest. In Figure 10, the actual rent paid is represented by the highest rent willing to be paid by the farmer, which is WXY. The third conclusion is that equilibrium quantities of land are found by selection of the proper bid rent function for each user. (Alonso 1964, pg. 41-42)

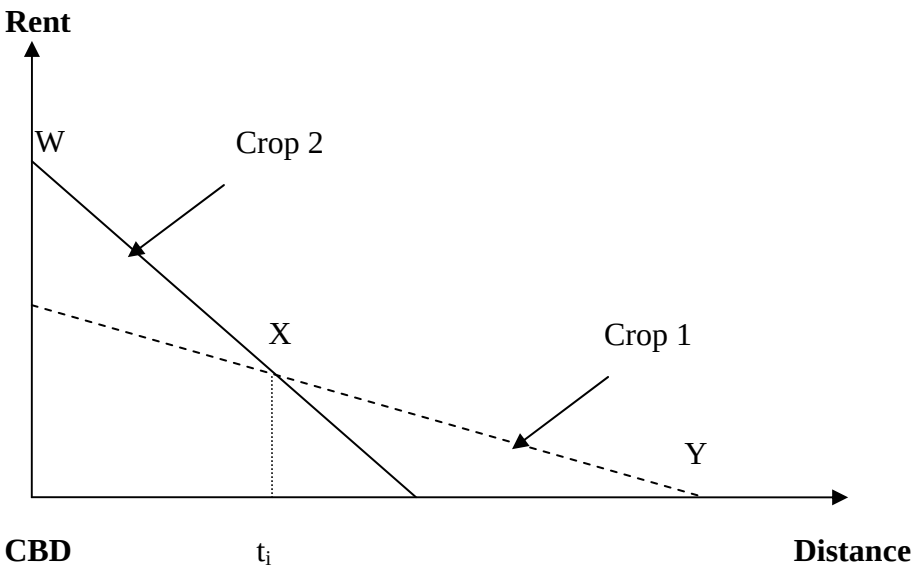


Figure 10: Bid rent functions for two crops

(Sources: Alonso 1964, pg. 40)

In determining the location of firm, it is required to consider the bid rent curves for a firm and the existing structure of land prices. Figure 11 shows the bid rent curves for a firm. From point of view of the firm, it is much preferable on BPC_1 to BPC_2 and then BPC_3.

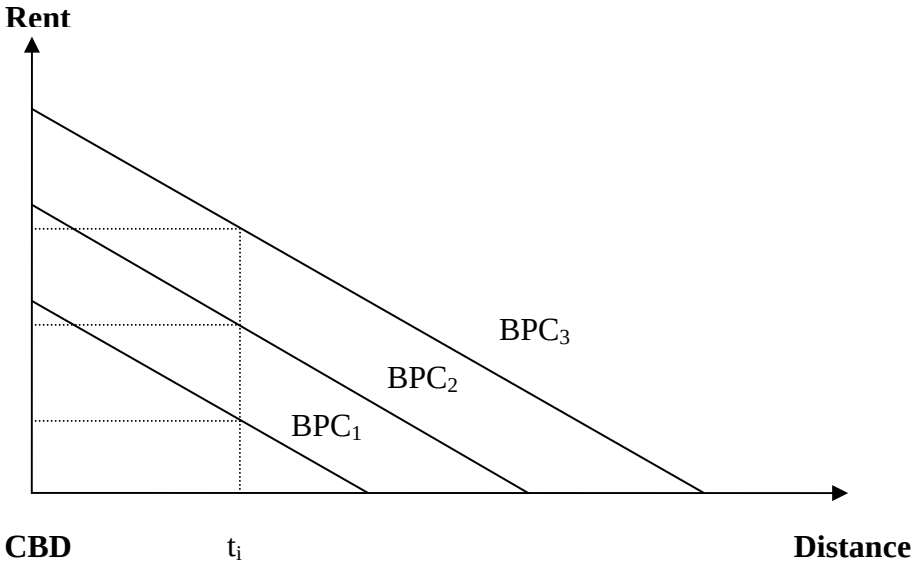


Figure 12: Bid rent curves for a firm

(Sources: Alonso 1964, pg. 56)

Figure 12 shows bid rent curve in the market. In combining Figure 11 and Figure 12, showing both preferences of the firm and actual market situation in Figure 13, the location of the firm, distance of t_c from the CBD, can be spotted at the point of intersection of the bid rent curve for a firm and the lowest bid of price for the land in market, at where the profits of the firm area maximized.

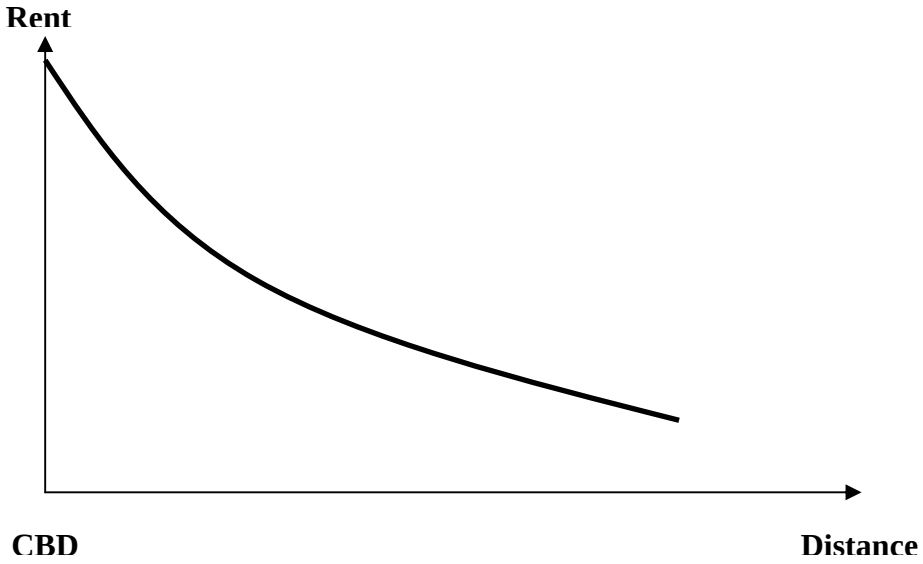


Figure 12: Bid rent curve in the market

(Sources: Alonso 1964, pg. 57)

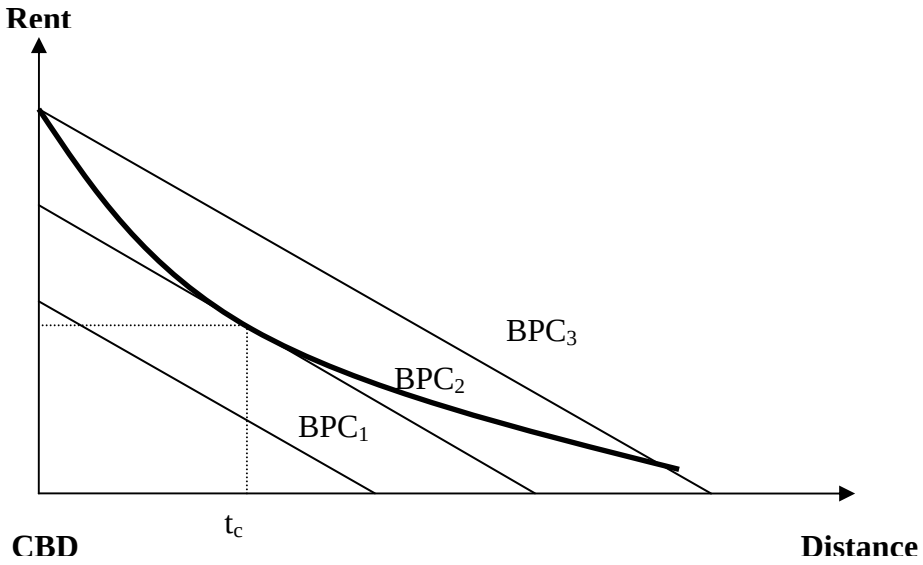


Figure 13: Equilibrium of the firm

(Sources: Alonso 1964, pg. 57)

The residential bid rent curve is

> *"the set of prices for land the individual could pay at various distances while deriving a constant level of satisfaction."* (Alonso 1964, pg. 59)

The residential bid rent function is the amount that a household could pay for rent at different location with differing transportation costs such that the same level of satisfaction is achieved, i.e. the household is on the same indifference curve. This formulation allows for the possibility that different amounts of housing space could be chosen at different locations. Also it allows for the possibility that higher income households end up locating in the suburbs because of the relative cost of open land space there compared with locations closer the CBD. Similar to the bid rent curve for the equilibrium of the firm, the location of housing a household willing to buy, which is t_c shown in Figure 14, is determined by the utility levels and the bid rent curve of general residential market.

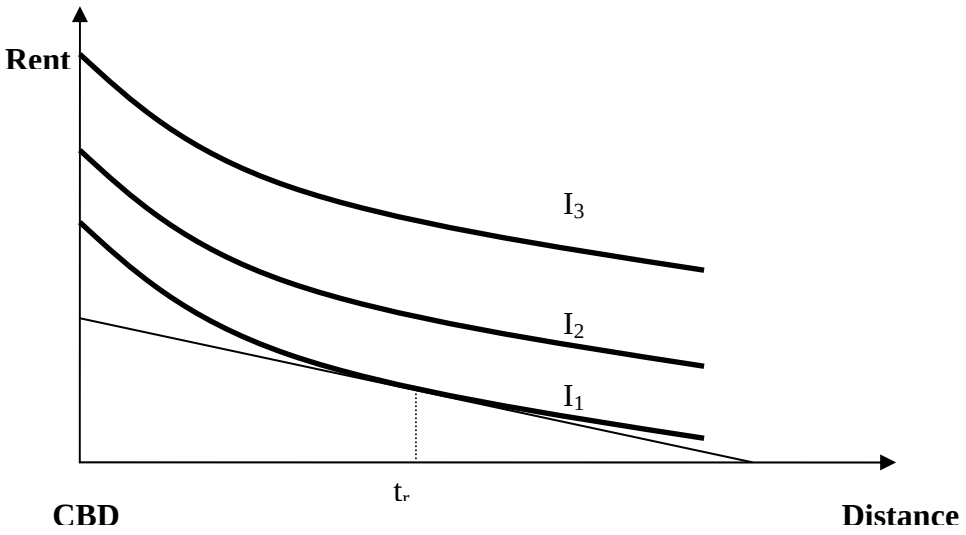


Figure 14: Residential bid rent curve with equilibrium indifference curve

(Sources: Alonso 1964, pg. 60)

Alonso emphasizes three points in his description of the bid rent curve. Firstly, the bid rent level of each individual or household is unique. Secondly, every bid rent curve represents a given utility level. Different bid rent curves represent different utility levels, similar to the well-known indifference curves. Lastly, prices represented by the bid rent curve have no necessary relations to actual prices: "A bid rent is hypothetical, merely saying that, if the price of land were such, the individual would be satisfied to a given degree." (Alonso 1964, pg. 59)

The transportation system in Alonso's model follows the assumption that its function is to move commuters from the residential ring to the edge of the CBD, but not transport commodities. Workers either consume at work or they carry goods home from work. Therefore, such assumption means that transportation is ubiquitous.

Criticism on Alonso's theory

However, there are lots of criticisms on Alonso's theory, especially on the assumption of the model of a city made up of equal-income household. Glaeser, Kahn and Rappaport (2000), together with Margo (1992), Mieszkowski and Mills (1993), and Mills and Lubuele (1997) in contrasting opinions, observes that Alonso does not consider there are rich community and poor community in a city.

Margo (1992) finds that the poor normally resides in central cities and middle-income individuals generally live in suburbs. It is because the poor prefers to choose to live where the housing stock is older. Besides, Mieszkowski and Mills (1993), and Mills and Lubuele (1997) find that the rich moves from city centers in considering the crime,

schools and other urban social problems. Karz, Kling and Lieman (1999) discover that the rich appear willing to pay to avoid proximity to the poor, due to low quality schools and crime.

LeRoy and Sonstelie (1983) argue that low cash fixed costs but high fixed and marginal time costs make public transportation, which is inexpensive but slow, differentially attractive to the poor. While the rich has more potential in using cars, which are expensive and fast, will make him, who have the lower marginal cost of commuting to live further from the metropolitan work center.

Glaeser et al (2000) disagree with their findings that housing market cannot explain much of the urban centralization of the poor. It is because the cost of housing for the rich, comparing with the cost of housing for the poor, does not decrease in suburbs. Across metropolitan areas, it is found that the urban centralization of the poor is greatest in suburbs where the poor have the greater housing market incentive to suburbanize.

Richardson (1977) divides the classes, in minimum number of two, into the rich and the poor. The residential distribution in different types of city can be easily represented by bid-rent functions. Figure 15 shows the residential pattern of the developed countries. The poor have steeper bid rent function than the rich, showing that the poor live near to the work in order to economize on transportation cost resulting in overcrowded conditions, while the rich have a high income on the demand for space. Figure 16 shows the reverse case in developing country, in which the rich have steeper bid rent functions, indicating that the rich tend to live at close-in locations, while the poor tend to live on the periphery of the city in squatter settlements.

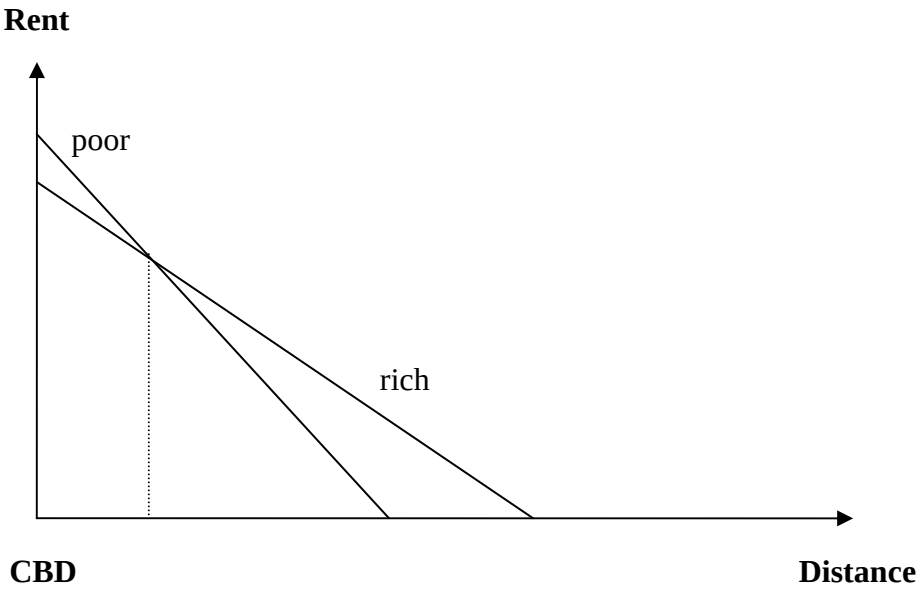


Figure 15: Residential distribution pattern of developed country

(Sources: Richardson 1977, pg. 103)

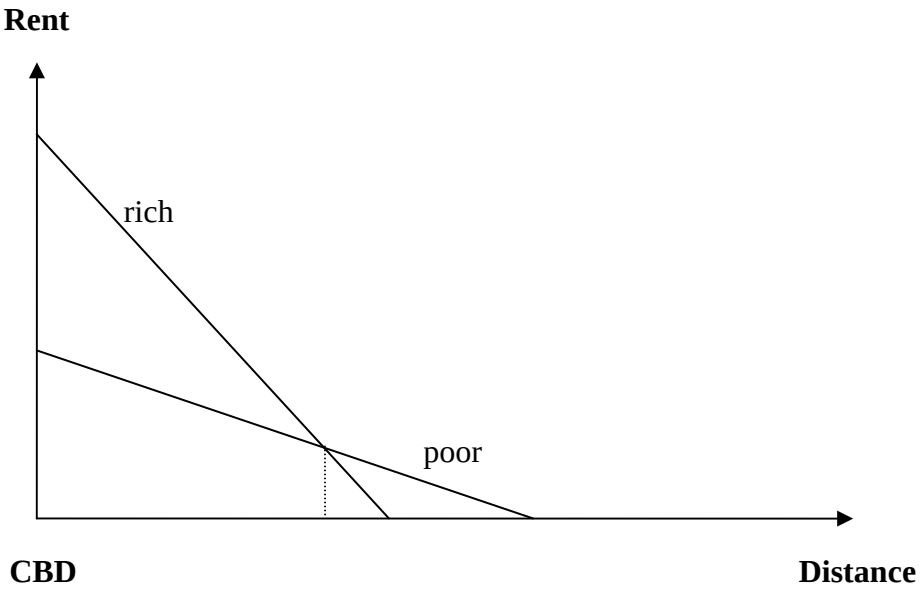


Figure 16: Residential distribution pattern of developing country

(Sources: Richardson 1977, pg. 103)

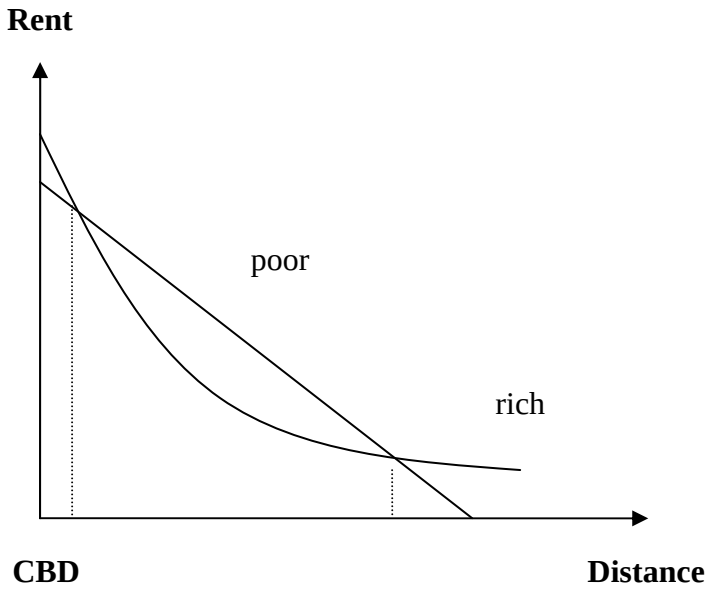


Figure 17: Residential distribution pattern of developing country

(Sources: Richardson 1977, pg. 103)

Besides two general types of city, there are two more examples. In some cities, there is the origin of two wealthy residential areas, assuming that the bid rent function of the rich is sufficient curved to intersect that of the poor twice, as shown in Figure 17. It shows that the rich want to live in very close to the center to minimize the time cost, and in the suburban to have more space, access to open country, etc. Once the population increases, an increase in the income of the rich may compress the area occupied by the poor, and ultimately, squeeze them out of the city, becoming the one-class city shown in Figure 18.

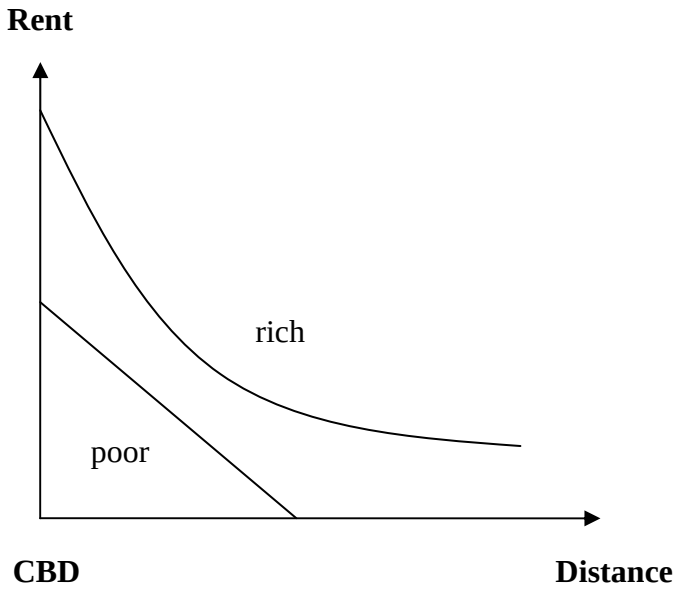


Figure 18: Residential distribution pattern of the one-class city

(Sources: Richardson 1977, pg. 103)

Richardson (1977) notes the empirical existence of positive rent gradients due to congestion externalities including good and bad features of the neighbourhood where the household locates, such as neighbourhood amenities and characteristics of environment quality. Also, suburbanization of jobs makes the people to receive lower wages. Therefore, the wage gradient must be introduced so that workers in the CBD are compensated with higher wages for having access to the CBD. The number of work trips plus shopping trips can be allowed to change by introducing a gravity-model effect in which the number of trips is inversely proportional to distance. The result is that households living far from the CBD prefer to sacrifice consumption for more leisure.

Linneman (1982) further states that higher income families have higher spending on transportation that induces them to live relatively near the work site. Where the rich

people like to inhabit depends on their sensitivity towards price and location respectively, which is varied from one place to the other.

Giarrantani and Hoover (1990) criticize that Alonso does not take into account the opportunity costs associated with commuting. Therefore, in Alonso's model the primary effect of higher incomes on bid rent curves is through changes in the quantity of land demanded by the household. Since Alonso expects this quantity to increase with income, he argues that flatter bid rent curves, higher incomes, and locations more distant from the CBD go hand in hand.

There are numbers of writers such as Poon (1978), Forrest, Glen and Ward (1996), Gatzlaff and Smith (1993), etc. have criticized the theories of urban land use and value, due to their simplifying assumptions and the effect of modern working practices and living habits.

Beckmann (1973) examines the influence of family size on household location. He finds that single persons and childless couples live close to the CBD, while large families with few working members live on the periphery. However, Richardson (1977) argued that the result is obtained without introduction the factors of families living in the suburbs, such as preferences for large gardens, suburban life-styles and access to open space.

3.2.9 Criticism of theories of urban location and rent

There are numerous writers, including Anderson and Crocker (1970), Kain and Quigley (1970), Ball (1974), Evans (1973), Pickett and Perrett (1984), and Gallimore, Fletcher and Carter (1996), who criticize the theories of urban land and rent due to their simplifying assumptions and the influence of modern working practice and living habits. There is a change in land values and the pattern of uses caused by a change in income level or in the spatial pattern of consumer demand. A change in transport costs causes a greater effect on those uses that depend more heavily on transport. Also, the theories do not concern with land use interdependence, referred to as complementarily between neighboring land uses. All the change in land use is long term because of the long life of buildings, least contacts, neighborhood effects, expectations and uncertainty. As a result, changes in supply and demand towards equilibrium are slow. Most importantly, these theories unrealistically assume a free market with no intervention and perfectly informed market players. They pay no attention to spillover effects such as the filtering of land uses and property types and the pollution effects caused by transport.

Kain and Quigley (1970) and Wilkinson (1973) apply the hedonic method using factor analysis to estimate independent effects of various housing attributes found to affect the quality of housing units. They observe that higher income households with more education prefer to live in relatively high quality housing units located further away from the CBD. Ball (1974) notes that valuations of environmental quality tend to be income elastic for high-income groups. Kohlhase (1991) notes that the impact of an US Environmental Protection Agency announcement in Houston about a Superfund site has a negative effect on home prices. Pollakowski (1982) finds that households with higher

educational levels tend to live in low-pollution areas. Conway, Moore and Smolen (1992) examines homes located near landfills, which accepts a low level category of harmful waste from a variety of sources, tends to decrease property values. Geckler, Geckler and Kinnard (1995) find a negative effect to the property values of proximity to a smelter that was identified by the US Environmental Protection Agency in the 1980s as having potential liability for contamination of the soil in the areas surrounding the smelter. Reichert (1997) examines the effects of an industrial excess landfill on home values. He finds that the toxic waste landfill has a relatively quick, economically considerable and enduring impact on housing values. Bible, Hsieh, Joiner and Volentine (2002) examine the sales prices of homes. They find that several amenities increase the value of the house, while the age of the home decreases value and the location of a home in a neighborhood found to be contaminated results in a negative influence on home values.

One of the assumptions frequently used is that all jobs and non-residential activities are located at a predetermined city center, which is usually designated as the CBD. However, Alperovich (1982) identifies three problems may arise. First, there are many small urbanized areas for which no official delineation is available. Secondly, many large urbanized areas have undergone rapid growth, which may lead to a shift of the location of the CBD from its traditional place to a more suitable one. Thirdly, the reported boundaries of the CBD of some big urbanized areas are too vast and a finer delineation is needed.

These theories which explain land use allocation, growth and pricing is challenged after the appearance of greater flexibility of location as a result of increased car use, lower

transport costs, and better information and communications technology (Meier 1962). However, these theories are still difficult to counter as they retain a logical appeal.

The relationship between urban location and rent is seen as increasingly complex. Land supply in the centre is limited and competition increases rents. At a certain level of transport provision, diseconomies of scale set in and lead to congestion. Other influences include planning, declining importance of manufacturing, rising administrative employment and more multi-regional organizations. The influences, in common with disadvantages of city centre locations such as congestion, parking, high rents and taxes, have led to decentralization. But despite predictions that decentralization would continue at an increasing rate, the city centre has not been abandoned. The need for face-to-face connection with clients or complementary activities remains necessary to many businesses. Economies of concentration, agglomeration and complementarily can outweigh the problems associated with general accessibility. (Meier, 1962)

3.2.10 Conclusions

Henneberry (1998) indicates that the relationship between accessibility, property values and land use pattern preoccupied early theorists. Traveling costs are traded off against rents and population densities, from the CBD to suburbs of a monocentric city. The CBD has declined as the prime location of employment and services in the modern city because accessibility is now heavily car-dependent and peripheral centres of activity have grown. In summary, accessibility has become a more complicated factor requiring more experienced treatment and accessibility is required to be studied more thoroughly in order to understand the locational advantages of individual properties rather than rely on

traditional bid rent theory that there is the peak rent in the CBD. For example, if the relative transport costs of a site are reduced either directly via a transport subsidy or indirectly via an increase in accessibility due to public transport investment, this will result in increased demand, leading to a rise in land and property values. If the changes in value are substantial enough they may start property investment and development, causing a change in or intensification of land use (Henneberry, 1998). Property values and land use change data are, therefore, good proxies for occupier demand in response to changes in accessibility.

3.3 Agglomeration Theory

3.3.1 Introduction

The studies from various writers such as Kuehn and Hambuger (1963) and Stollsteimer (1963) state that given a spatial allocation of demands for a specific commodity, fixed costs must be incurred for setting the facilities that produce this commodity and transportation costs must be produced to distribute it from the facilities to the consumers. The aim of the agglomeration is to determine the number and locations of facilities so as to minimize the sum of production and transport costs. The first writer having major inspection of industry concentration and localization of specialized industry was Marshall.

3.3.2 Marshall's agglomeration theory

Having noticed the concentration of certain industries in particular centers, Marshall (1920) proposes that the localization of industries occurred through factors of physical conditions[11] , patronage of courts[12] and deliberate invitation of rulers[13].

Once industry is localized, it tends to remain in that area for a substantial time. The advantages of localization are suggested by Marshall as the inherited skills developed over time, the growth of ancillary activities, use of highly specialized machinery, benefits from technological spillovers and a local market for special skills. Nevertheless, there are

[11] climate, soil type and resources such as mineral deposits.

[12] the demands of a royal court for certain goods attracted skilled workers who passed on their knowledge and led to the duplication of those skills even after the court had progressed

[13] rulers attracted skilled artisans to settle in particular centers. These workers passed on skills to the locals, so broadening the overall skills base

also disadvantages. A heavily localized industry can make radical demands for one kind of labor, such as male for iron industry. Besides, a region dominated by one industry is weak if this industry suffers from reduced demand. The localization of industries is influenced by external factors such as the improvements of the means of communication, resulting in reduced transportation costs. This will prevent the need for different industries to concentrate but make possible that to remain localized some distance from centers of demand.

Marshall also examines agglomeration effects. He states that “When an industry has thus chosen a location for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighborhood to one another....A localized industry gains a great advantage from the fact that it offers a constant market for skill....Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require; while men seeking employment naturally go to places where there are many employers who need such skills as theirs and where therefore it is likely to find a good market. (Marshall, 1920, pg. 225)

In general, externalities occur because of mass-production, the formation of a highly specialized labor force and the invention of new ideas, both derived from the accumulation of human resources and face-to-face communications, the availability of specialized input services, and the existence of modern infrastructures.

3.3.3 Perroux's growth pole theory

The theory of a growth pole is developed by Perroux (1955). He points out that development has to be come into effect by agglomeration of economic activities in theoretical space. Perroux considers it as an economic phenomenon which has a complicated system, but this concept of a growth pole has become an idea in good currency which enjoys the honor of all mythic catchphrase in regional development (Lasuen, 1969, pg. 20). Some articles were published regarding the growth pole (Darwent, 1969) (Moseley, 1974). In early 1970s, "reliance on growth pole analysis was a dominant characteristic of operational regional planning in both developed and developing countries." (Richardson and Richardson, 1974, pg.163) However, few studies actually tried to fully understand this theory as "the theory was too complex, too abstract, and too non operational" (Higgins, 1988, pg. 44).

Perroux disapproves of the analytical frameworks of modern economics in his previous work (Perroux, 1950). Previous economists considered the economy as a set of aggregate variables such as capital, savings, investment and consumption. The main-stream of growth theory was developed as functional analysis which assumed the equilibrium path of growth. Perroux criticizes this analytical framework and states that "treat the nation as a local complex of factors of production, of which the contents are determined by the relative supplies of these factors contributed by various nations and in this framework all individuals are 'contained in a container' as a 'big individual'" (Perroux, 1950, pg. 33). He supposed there should be a more dynamic mechanism in economic growth. He indicates that all people are born as a member of a society or a group and know very well that society is composed of groups with conflicting interests (Higgins, 1988, pg. 35).

Therefore, he refuses the concept of a basic harmony of interests in society. He states that "each individual carries energy for change, usually in the form of expansion energy" (Perroux, 1988, pg. 51). The tendency of human forms some oligopolistic leading actors. Thus, Perroux further states that "economies and societies are pulled and pushed in various directions by ever-changing constellations of leading actors, with constant groupings and regroupings through irreversible time, so that the distribution of power is constantly changing too" (Higgins, 1988, pg. 36).

Perroux argues that apparent economic growth is not smooth or regular, and he associates it with structural change. "The appearance and disappearance of industries... the varying proportion of various industries in total output in the course of successive periods.... the different rates of growth for diffusion of the growth of an industry" (Livingstone 1979, pg. 56). The picture of an uneven nature of growth leads to the concept of growth poles.

Perroux (1950) mentions the term pole and centre and states that formation of each firm are geographically dispersed, and bounds of organization of changeable strength are formed among them. He argues that "as a field of forces, economic space is composed of centres from which centrifugal forces emanate and to which centripetal forces are attracted" (Perroux, 1950, pg. 27). As a reason for agglomeration, he claims that dominant firms are comparatively efficient, and they can get an effective use of innovations and so increase output more greatly than others. The extent of this effect will spread and be received by everyone in society through a multiplier effect. Therefore, a particular intensity of polarization must be a necessary attraction to benefit the masses.

Perroux states that "the fact, rough but solid, is this: growth does not appear everywhere at the same time; it manifests itself in points or 'poles' of growth, with variable intensities; it spreads by different channels with variable terminal effects for the economy as a whole" (Livingstone 1979, pg. 56) However, the growth poles are not individual phenomenon. Perroux focuses on the relationship of propulsive units, and states that the growth pole is a propulsive unit coupled with the surrounding environment. To distinguish this relationship from the simple agglomeration theory, he restates "I went from the concept of 'growth pole' to that of 'pole of development'..... the growth pole is a set that has the capacity to induce the growth of another set ("growth" being defined as a lasting increase in the dimensional indicator); the pole of development is a set that has the capacity to engender a dialectic of economic and social structures whose effect is to increase the complexity of the whole and to expand its multidimensional return" (Perroux, 1988, pg. 49)

3.3.3 Weber's agglomeration theory

Following *3.2.5 – Weber's theory*, Weber (1929) introduces the agglomerating factors and the deglomerating factors. The transportation and labour factors spread the industries over the surface, fixing them at places of 'lowest regional cost'. The agglomerating factors are likely to draw the industries of such a region together into agglomeration, while the deglomerating factors have a dispersing effect. Examples of agglomerating factors are savings of overhead costs, savings caused by better connections with marketing organization and savings caused by closer proximity of supplementary industries. The deglomerating factor is rent which increases with increasing local concentration of industries, resulting in competition of land. Weber introduces

agglomerating force which consists of both sets of factors and changes the distribution of manufacturing industries. This force in reality only reinforces an agglomeration due to the transportation factors and labour factors.

As mentioned before, isodapanes are made up around the points of lowest regional cost, while a critical isodapane is the line where the attraction forces of the original points are offset by the agglomerating force. The main differences are that the places of agglomeration are not fixed places and the force of attraction is not fixed. The agglomerating force will be effective only if critical isodapanes of a number of isolated processes have intersecting segments that offer savings of cost sufficient to offset the additional cost of diversion to the new place.

Weber does not investigate the factors of agglomeration in the way that he analyzes weight, distance and the other factors of transportation and labour cost. He summarizes the cost that can be decreased by agglomeration to constitute the form value of the industry. He invents a form value index, representing the attraction of the places of agglomeration relying on the ratio of the form value cost to the weight of the product. One the other hand, he finds that the diversion of the manufacturing industry depends on locational weight, which is the weight to be transported during the whole process of production. At last, he finds out form coefficient, which is the ratio of the form value to the locational weight, affecting the diversion of industry.

3.3.4 Other agglomeration theories

Weber and Hoover (1936) suggest there are two existing classifications of agglomeration economies. One is localization economies, which are external to firms but internal to an industry. Another is urbanization economies, which are external to industries and depend on the overall scale and scope of the economic activity in particular location. This classification is used to a great extent in empirical studies as surveyed in Henderson (1988). While such a classification mostly emphasizes the supply side of the economic system, agglomeration economies also function on the demand side.

Stahl (1983) states that "in a large city an individual may derive a higher utility from spending a given amount of income than in a small town ...even if the prices for commodities obtainable at both locations are higher in the former than in the latter." (Stahl, 1983, pg. 318) A result follows straightly from the convexity of preferences. A factor that affects the development of an urban center is the cost of transporting such variety in the countryside. In addition, Haig (1926) states that "The great bulk of population...must work and must consume most of what they earn where they earn it. With them consumption and production is practically a simultaneous process and must be carried on for the most part in the same place. To them location is of interest both in its effects upon production and in its effects upon consumption." (Haig, 1926, pg. 185-186) Lampard (1955) agrees with Haig that each city gives out a variety of social purposes and meets a variety of human needs, and does not just provide goods. He also clarifies that a variety-like argument similarly applies to intermediate goods used by firms, while the principal function of the city today in terms of employment it creates is the provision of services rather than manufactures.

3.4 Hedonic pricing model

3.4.1 Introduction

> *"It has long been recognized that the provision of public infrastructure has a profound influence on the pattern of urban development and the spatial distribution of urban real estate values."* (Damm, Lerman, Lerner-Lam and Young, 1980)

Empirically, the impact of changes in accessibility on property values, prices and yields may be measured using hedonic pricing models.

The hedonic pricing model is first used by Griliches in the study of fixed assets in 1961. The technique is widely used in housing studies to identify problems such as racial discrimination, neighbourhood change and accessibility to work. The utility bearing attributes include physical factors of the property, accessibility factor regarding location of the site in relation to employment centres and other recreational facilities, social and economic factors of the neighbourhood including the presence of amenities such as views, parks, schools and community services.

Lancaster's (1966) theory of characteristics states that goods create utility through the properties or characteristics that bundle together to make them and that goods can be arranged into groups derived from the characteristics they contain. Consumers then purchase goods within groups based on the number of characteristics they possess per dollar.

Rosen (1974) modified Lancaster's theory to make it more applicable to durable goods by saying that, within any group of goods, consumers choose to purchase only one good. Generally, it can be said that Rosen pioneers the analysis of hedonic markets in a perfectly competitive setting. He proposes an econometric recognition strategy for recovering preferences and technology from hedonic markets. He firstly suggests the use of hedonic pricing analysis to indicate the market clearing prices related to bundles of housing services. He has a definition for hedonic price as the implicit prices of attributes and is revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them.

3.4.2 Hedonic pricing analysis of the relationship between land value and transportation

Damm *et al* (1980) states that it had been recognized that the provision of public infrastructure has a profound influence on the pattern of urban development and the spatial distribution of urban real estate values. There have been many studies measure the impact of changes in accessibility on property values, prices and yields by using hedonic pricing analysis. (Wacher, 1971) (Allen and Boyce, 1974) (Dewees, 1976) (Dvett, Dornbusch, Fajans, Falcke, Gusman and Marchant, 1979) (Bajic , 1983) (Pickett and Perrett, 1984) (Laakso, 1992) (Walmsley and Perrett, 1992) (Gatzlaff and Smith, 1993) (Forrest, Glen and Ward, 1996) (Ganesan, So and Tse, 1997) (Chau and Ng, 1998) (Henneberry, 1998)

Hedonic pricing analysis is used to develop a mathematical relationship between the value of a property and its attributes about location, physical and economic aspects. One

of the examples is regression model. It is the common technique for empirical studies of urban rent determination in general and the impact of transport investment on property values. To the built environment decisions, most issues are regarding proximity, neighborhoods, accessibility and complementary. These issues and their influence on property values are usually handled by using neighborhood and distance variables in the determination of rent. The inclusion of sophisticated proximity variables appears to be increasingly popular as technology becomes available by which to calculate the values easily. In many of the hedonic pricing analysis studies neighborhood factors and access variables emerged as powerful determinants of price.

Spengler observes assessed land values from the early 20th century near most of the rail routes in New York at that time (Damm *et al*, 1980). He concludes that the new routes shift values rather than increase aggregate land value and tend to increase land value in the centre at expense of periphery. Since rail routes are one of many factors influencing land values, it may be offset by other factors that lower land values. Also, presented urban areas tend not to reveal a noticeable increase in land value when new routes are opened. Similarly, an area already served by rail routes will reveal only a small growth in land value if another route is added.

Wacher (1971), Allen and Boyce (1974), Dewees (1976) and Dvett *et al* (1979) have done the similar research about the effect on property values of changes in transport infrastructure.

Wacher (1971) studies the property values during the opening of the Victoria Line in London in 1969. He finds that values of properties within the catchment area of the line increases up to five per cent when comparing to those outside the catchment area.

Allen and Boyce (1974) study the impact of the Lindenwold High Speed Line on residential property prices by using sales data for the passageway through which the line passed. They confirm that there is really a positive impact of new line on property price.

Dewees (1976) inspects residential sale prices to cut off the relationship between land values and transport facilities in Toronto. He concentrates on adjustment in relative values along a specific street by simulating door-to-door access costs before and after construction of a subway. The major result is an increased rent gradient next to the subway stations. The analysis is different from numerous researches by modeling effects of price around a subway station rather than the distance to the CBD. Dewees comments that the higher the price paid for land, the more capital will be applied to it. It causes the increase of its output and intensity of use, and also the increase the gradient in the centre and flattening it on the periphery. He also states that while modeling the effect on property values of a new subway station, the influence will be reduced if, say, half of the residents do not use the subway. This will be identified in a shallower slope near the station. He continually argues that proper definition of accessibility requires that the transportation performance of all modes be expressed in dollars per mile, based on the many characteristics of each mode.

Dvett *et al* (1979) use multiple regression analysis to examine the impact of the operation of the Bay Area Rapid Transit in San Francisco on residential property values. In the

study, independent variables, such as proximity to the Bay Area Rapid Transmit stations and railway, and proximity to freeways, schools and parks, are included. It is found that a small but significant positive effect on the price of single family residential property at the stations, out of total six stations which are examined.

Damm *et al* (1980) study the response of residential and retail property values in expectation of the development of a rail transit system. No examination is carried out to find whether property values changed due to the Metro development. This is reasoned by the fact that potentially considerable increases in value for a relatively small number of properties close to the stations would be outweighed by negligible decreases in value for the remaining substantial majority of properties. As a result, aggregate property value for the urban area would remain unchanged and intra-urban shifts would be practically undetectable unless a massive sample of real estate transactions is collected. In Damm *et al* study, they used cross-sectional data, ranging from 1969 to 1976. They find that the distance to the nearest station is significant to the transaction price. They prove that the greater distance leads to lower value and such effect is decline rapidly. Although such effect is more obvious for retail property, it is still significant in applying on residential property. On the joint nature of urban investment programmes, Damm *et al* state transport improvements is part of a comprehensive development and identifies implicit price effects of one constituent of the investment programme is not easy.

Martin Vorhees Associates, Scottish Development Department and the Transport and Road Research Laboratory (1982) carry out the Glasgow Rail Impact Study and find that there is positive impact on the residential price due to the provision of new rail services since 1978, in which the underground in Glasgow is modernized and the railway is opened next year, linking the north west and the south east rail tracks.

Bajic (1983) studies the effect of the Spadina Subway Line on Toronto property values. The change in transportation infrastructure is regarded as the variation of the locational attributes which work as proxies for accessibility to employment centres in a hedonic pricing analysis. The analysis focuses on work trips and deduces that direct savings from transport improvements had been capitalized into values of houses.

Pickett and Perrett (1984) scrutinize the influence of the Tyne & Wear Metro on residential properties in areas which the lines cross. The goal is to find whether enhanced accessibility owing to the addition of public transport in the area has any effect on residential property values.

Laakso (1992) carries out a study to examine the impact of numerous factors, especially the effect of the new metro rail system, on the prices of residential house in Helsinki by the means of a hedonic price analysis. The outcome is that both time distance to the city centre and nearness to metro stations have a considerable effect on the market price of residences. Walmsley and Perrett (1992) state that there is no obvious difference between housing prices near to and distant from the Metro in Marseilles after opening for one year.

Gatzlaff and Smith (1993) disagree previous reports of the influence of rail development on property values by proposing that they merely play an indirect role in urban renewal and are targeted at areas with land availability which is attractive for development. The greatest effect is in the CBD but only if coordinated with other public investments and incentives, and in areas with available land and a demand for space. (Gatzlaff and Smith, 1993) They find that transit is most successful while it is developed in crowded area and

matched with other land use policies. Public transport routes have a much greater effect on values when an alternative road transport network does not exist.

Gatzlaff and Smith (1993) examine the impact of the redevelopment of the Miami Metrorail system on the values of residential properties adjacent to the stations. However, it is found that Miami is not a suitable area for study as there us no large central business center. Also, the results show that there is only weak effect of the announcement of the redevelopment of the system on residential values. In addition, there is no visible variation with distance from the station. There is the greatest effect in higher-price neighborhoods. Investment in the Metrorail does not lead to significant regeneration of neighborhoods. Difference with previous studies is that the development of a Metrorail has had an insignificant impact on residential property values in a decentralized city like Miami, indicating that the system has had little effect on accessibility.

Forrest *et al* (1996) examines the relationship between the availability of rail services and the house prices in an urban area in Manchester. By using hedonic pricing analysis, they identify the degree of the difference of prices between properties with good access to rail services on the new Metrolink routes or existing rail routes and properties that do not, before and after the opening of the Metrolink service. They find that house prices increase with distance from the CBD. However, this effect is probably due to the fact that plot size was not considered in previous studies and plot size increases further away from the CBD. Also, people are willing to pay more to run away from problems associated with living in a city centre. They find that proximity to a stations tends to lower property price and it is explained by the result of associating location along the railway with older and less valuable neighborhoods. The result raises a problem, resulting their arguments on the

findings of Damm *et al* (1980), who find a positive relationship between house prices and proximity to projected stations, may overstate the benefits of the line because the stops are not located randomly as they would need to be to secure unbiased estimates. Instead the stops are located at the attractive areas or areas that are planned for revitalization, usually they are located in conjunction with the new transport infrastructure. Consequently, observed residential price differentials may give the verdict of the housing market not on the transit line per se but on the advantages of living near all the amenities associated with the route of the transit line. (Forrest *et al*, 1996) Forrest *et al* conclude that the Metrolink in Manchester is an improvement scheme, developed on brown field land.

Ganesan *et al* (1997) argue that changes to the transport infrastructure will affect other housing attributes, including the environmental quality, which change the implicit prices, but not be a linear effect on the accessibility attribute alone. They examine the significance of transport on housing prices in Hong Kong. To manipulate various internal attributes and environmental characteristics, samples are picked out for hedonic pricing analysis which includes households with similar locational characteristics and income levels. Accessibility is computed as distance to nearest stop on the mass transit railway (MTR), bus or minibus route. Walking time is computed and dummy variables are made which stand for dwellings with greater or less than 10 minutes walk from a transport node. The results show that accessibility to minibuses emerges as the most influential effect on house prices, but not the buses. In the study, several variables in the analysis are correlated, for instance floor level and orientation. However, the main variables under consideration, i.e. accessibility to MTR, bus and minibus stops would be correlated

because they may be co-located with one another and with other variables such as shopping centres and sports facilities.

Chau and Ng (1998) investigate the improvements in public transport links between urban and suburban areas normally result in decentralization of population. This affects the price gradient of properties along the rail route. There is the decline in price gradient as prices in suburban areas increase relative to those in urban areas due to increased demand for suburban residential properties. On the other hand, the price gradient increases as population density increases and the environmental quality decreases in suburban locations. The study was to examine the price effects in two areas linked by the Kowloon-Canton Railway (KCR) before and after it was electrified in 1983. The study concentrates on the price gradient for residential properties along the rail route by comparing relative transaction prices of residential properties at two stations on the KCR route before and after electrification. To control other factors, homogeneous samples are made and hedonic pricing analysis is used to control the effects of other price influences that are treated as variables. The results reveal that the electrification of the KCR decreases the price gradient but a period of time is required for the relative price levels to stabilize due to people's adaptation to change. They conclude that an improvement in public transport lowers the transportation costs regarding commuting time and it leads to a decrease in the price gradient along the rail route.

Henneberry (1998) studies the impact of the development of the Sheffield Supertram on residential property values. The results recommend that "anticipation of the construction of the Supertram acted to reduce house prices… On completion of the Supertram, the negative impact has disappeared. However, the analysis of prices is undertaken only four

months after the full opening of the system. It may take much longer for the benefits of Supertram to be fully appreciated by homeowners." Besides, he refers to the diminishing returns that set in when the area, already served by transport facilities receives new transport investment. The effect on land and property values will be less than if such investment was made in the area that had insufficient or no transport infrastructure. Laakso's (1992) study is also stricken by this problem. He studies the influence of the Helsinki Metro on housing prices, and the models are created for three years. The first of which is before the metro was operated. By failing to take in a variable that measures distance to the non-existent metro in this first year, the advantages of living next to the metro in the later two years may be the result of being close to locations that are attractive enough to warrant metro stations.

3.4.3 Criticism on hedonic pricing analysis

Although hedonic pricing analysis was widely used in previous studies, there are shortcomings in using this method. Rosen (1974) mentions that hedonic pricing analysis only indicates the set of market clearing prices, but not the supply or demand functions. He also mentions that the value of properties is tended to be over-stated as the market prices used in the analysis indicate the highest successful bid for property.

Also, it does not give a general basis for the selection of variables. Linneman (1982) states that hedonic pricing analysis requires a lot of information about each property and also there are no definite rules which variables are used and how the regression equations are made.

The hedonic approach tries to compute directly the influence of selected variables on land values. Its clear advantage is that if land markets are operating properly, prices will reflect the present discounted value of land rents into the infinite future. In principle, this approach explains the full range of farmer's adaptations. The limitation is that the validity of this method requires consistent estimation of the effect of variables on land values. Hoch (1958 and 1962) and Mundlak (1961) recognize that unmeasured characteristics, such as soil quality, are a vital determinant of output and land values in agricultural settings. Consequently, the hedonic approach may confound variables with other factors and the sign and magnitude of the resulting omitted variables bias is unknown.

Dunse and Jones (1998) emphasizes that many studies using hedonic analysis assume that the hedonic prices are the same across markets and property types. On the contrary, different attributes are valued differently when combined with other attributes. For example, parking is more valuable in the CBD. Also these studies which have attempted to compute the effect that various property attributes have on value shows consistently higher explanatory powers when regressing residential property variables than is the case for office property. This is partly due to the fact that office rental values are consistent with respect to size, which adopt rent per unit area as the dependent variable, while capital values are used in many residential analyses. One or more of the independent variables either directly measures or acts as a proxy for size. The size variable can contribute considerably to the explanatory power of the analysis. Hoesli, Thion and Watkins (1997) examine the rental values of residential apartments in Bordeaux and conclude that most of the explanatory power for the different variables results from the surface area component.

3.4.4 Conclusions

Blackley (1983) states that hedonic pricing analysis is especially suitable to identify the determinants of housing and land prices, due to its explicit recognition of the heterogeneity of urban housing and land sites. Most studies associated with the assessment of the influence of an individual infrastructure development or improvement on the values of owner-occupied dwellings. The identified effect of transport infrastructure on housing prices was usually small and the influence of railway systems on property values is vastly localized and contextual (Henneberry, 1998). With the assumption of a monocentric city, previous studies considered accessibility as the distance from the CBD. Cost related to accessibility was measured by using distance and travel time as proxies in later studies (Coulson and Engle, 1987) (Chan, 2003). Many studies assume that there is an increase in accessibility as a result of an individual transport infrastructure. The studies try to find whether the improvement in accessibility is indicated by an increase in land and property values.

Chapter 4 Methodology

4.1 Introduction

Having the local concentration of economic activities with high population density in limited road space hinders extensive use of private cars in Hong Kong. This brings about a high reliance on public transport. It is found that Hong Kong public transport carries about 90 per cent of all persons (Hau, 1988), and more than 80 per cent of motorized trips are commenced by public transport (Meakin, 1994). According to Hong Kong 2004[20], 11 million commuter trips are made in Hong Kong every day, in which 89 per cent are taken on public transport. Therefore, one supposes home buyers to be willing to pay more for housing units with easier accessibility to their work. This identifies the fact that housing is a heterogeneous commodity distinguished by a wide variety of attributes.

It is predictable that the completion of railway can improve the public transportation in the catchment area. According to Hong Kong 2004, rail travel accounts for some 30 per cent of the total daily public transport volume. As a result, it provides a chance to examine the influence of the improvement and the provision of public transportation in price gradient on the residential property price in the district along the rail line.

This study aims to examine the impact of rail line on residential property prices in Hong Kong. There are total 10 rail lines operating in Hong Kong, in which Ma On Shan Railway of KCRC will be the subject target of the study.

[20] http://www.info.gov.hk/yearbook/2004/en/index.htm

Usually, before the operation of a new railway line, there is construction period last for several years. During the construction period or at the day of announcement of the proposed railway project, people expect that there will be a change of residential property price as they all know that future improvement in the transportation system will lead to the increase of the residential property price lying near to the railway. The general expectation in the improvement of public transportation results in a decline of price differential between urban and suburban areas, having a positive impact on the property prices in the suburban areas.

Therefore, such impact will be studied in three periods, (i) after the announcement of the rail and before the commencement of construction works, (ii) during construction period, and (iii) during the operation of the rail.

4.2 Hypothesis

Recall from the first chapter, the hypotheses of this study are to test:

3. The improvement of public transportation will lead to a decline in the price gradient for areas linking by the railway in all three periods.

4. The proximity to the station will increase the residential property price in all three periods.

To study whether there is any effect of the railway on the price of properties nearby, it is required to examine the price gradient along the new railway. If there is a reduction of

transportation cost, owing to a diminished relative advantage of travel to the CBD from the area closer to the CBD, the price gradient is likely to be reduced. Also, it is required to look at the effect of the proximity of the residential properties to the railway station to observe whether purchasers will be willing to pay more as a premium for properties located nearer to the station for convenience.

4.3 Subjected target of the study

Ma On Shan Rail

There are total nine stations along Ma On Shan Rail, including Tai Wai, Che Kung Temple, Sha Tin Wai, City One, Shek Mun, Tai Shui Hang, Heng On, Ma On Shan and Wu Kai Sha. Out of these stations, Ma On Shan station and City One station are selected in the study to examine both hypotheses because there is sufficient transaction information of the property, which the property transactions existed before the announcement of the construction of Ma On Shan Rail.

The followings are the key dates regarding Ma On Shan Rail.

Date of announcement:	26-Mar-1999
Date of commencement of construction:	12-Feb-2001
Date of operation:	21-Dec-2004

4.4 Hedonic regression model

4.4.1 Selection of model

Rosen (1974) and Freeman (1979) state that hedonic pricing analysis is a technique to study the demand side of housing, assuming that a property is sold as a package of inherent attributes. Residential property price is influenced by the evaluation of consumer on varieties of attributes. Hedonic prices are the implicit valuations of the characteristics of the residential properties, which can be found out by using a regression equation. Particularly, a hedonic equation helps to explain the property price in terms of its own characteristics such as size, age, floor, neighbourhood characteristics, job accessibility, etc. Each of these attributes is assumed to be implicitly priced.

Large numbers of the attributes affecting the property price are heterogeneous in their nature, therefore the price cannot simply determined by the individual characteristics of the property. For instance, a change in the transportation cost will change the composition of the typical housing bundle, leading to the adjustments in consumer behaviour to the changing of relative prices of housing. The property price is not only determined by the demand for the attributes of the housing units, but also the demand within the region in which the units are located. The influence of different attributes varies with geographical locations. Therefore, owing to geographical differences, the potentially opposing influences of transport accessibility and environmental quality should be separated in the hedonic pricing analysis. It is practicable to select a sample in the regression with similar locational characteristics and income groups, which are assumed to have homogenous

tastes, so that the effects of various internal attributes and environmental characteristics of the neighbourhood are locational insensitive.

In this study, hedonic regression model is used because it provides a means to investigate the impact of Ma On Shan Rail on property price individually. Since the property prices are affected by numerous heterogeneous attributes, it is required to sort them out and eliminate their effect on the property price, resulting in reliable result to indicate the impact due to Ma On Shan Rail. Hedonic regression model can examine the effect of each attribute, named as the independent variables, on the property price as the dependent variable.

Among all types of hedonic regression model, semi-logarithmic regression is implemented because it is frequently used in real estate research. Examples of studies are Kain and Quigley (1970), Li and Brown (1980), Fallis and Smith 1985) and Cattopadhyay (1999). Semi-logarithmic regression can find the relative change in the dependent variable for a given absolute change in the value of the independent variables. Since the dependent variable serves as an indicator of some characteristics, value derived is more theoretically admissible. (Hosmer and Lemeshow, 1989)

As the impact of Ma On Shan Rail on property developments is reflected in the property price, property price is used as the dependent variable. Since other attributes, such as floor level, area of housing, age of the property, view of property has considerable impact on property price (Chau, Leung, Yiu and Wong, 2003) (Mok, Chan and Cho, 1995), these

attributes are taken into account, especially those relevant to the geographical characteristics along Ma On Shan Rail.

In the following, relevant statistics in hedonic regression model used for the analysis is interpreted. Afterward, attributes including in the model which affect the property value are discussed. Separated equations used to test the hypotheses are constructed and selection criteria of data of property developments along Ma On Shan Rail is made.

4.4.2 Interpretation of statistics

Hedonic regression will give out data in term of, for instance, the coefficients of determination, F-statistics for the equation, the t-statistics and coefficients of each variable. The purposes of these statistics are to test the significance of the model and the independent variables, and examine how the independent variables affect the dependent variable.

Coefficient of determination (R^2)

The value of R^2 shows the proportion of variation in the dependent variable justified by the variation in the independent variables. The coefficient of determination can have only positive values ranging from $R^2 = +1.0$ for a perfect correlation, either it is positive or negative, to $R^2 = 0.0$ for no correlation.

The advantage of the correlation coefficient, R, is able to indicate the positive or negative direction of the correlation but only the square root of the strength of the correlation. The advantage of the coefficient of determination, R^2, is to provide a measure of the strength of the correlation together with the true strength of the correlation but without an indication of its direction. (Korn and Simon, 1991) (Mittlbock and Schemper, 1996) (Ash and Shwartz, 1999)

For example, if R^2 is 0.9, it means that 90% of the change in dependent variable is owing to the change in independent variables. The remaining 10% change is unknown or unable to be explained by the independent variables in the model.

Adjusted Coefficient of determination (adjusted R^2)

Adjusted R^2 is a modified measure of R^2 that considers the number of independent variables included in the regression model and the sample size. Although the addition of the independent variables will always cause R^2 to rise, the adjusted R^2 may fall if the added independent variables have little explanatory power or if the degrees of freedom become too small. (Liao and McGee, 2003)

Both R^2 and Adjusted R^2 measure the strength of association between the dependent variable and the independent variables. In this study, both are important indicators to inform whether the result is worthwhile to interpret by examining how the property price is explained by input attributes.

F-statistic

The F-statistic is a test of the significance of the analysis of regression. It is used to test the probability of statistical coefficients is zero. It does this by calculating and comparing what are called generalized sum of squares. (Christensen, 2003)

In the case of testing a single coefficient, the F-statistic is the square of the t-statistic, and they are interpreted similarly. F-statistics are compared to a table of numbers which contain values of expected F-distributions to see if an F-statistic is greater than what can normally be expected in F-distribution. If it is greater than what the table indicates, it indicates that the model is statistical significance.

In this study, F-statistics is used to examine whether the model as a whole is significant or not. It is fundamental statistics as its fail indicates the fail of the entire model.

t-statistic

t-statistic aims to test the significance of the effect of the independent variables on the dependent variable. The calculation of t-statistic is to subtract the hypothesized value from the statistical estimate (b_i) and then dividing by the estimated standard error (Sb_i). In many, but not all situation, the hypothesized value would be zero. Therefore, the formula generally is:

$$t = b_i / Sb_i$$

Usually, when the value is larger, it is more likely that the value of the coefficient b_i is different from zero, resulting in more significant variable and the more accurate estimate. Therefore, the test of the statistical significance is to test whether the dependent variable is affected by the independent variable, but not to show the extent of effect of independent variable on dependent variable.

There is a critical value of t for a given significance level and degree of freedom. Once t-statistic is obtained, it will be used to compare with the relevant critical value which can be checked from the T-distribution under a degree of freedom, relying on the number of samples and the number of variables. It is called the t-test. Typically, the critical value will have a larger value if the desired probability is lower, and hence it will be more difficult for the independent variable to become significant to the dependent variable.

t-statistics shows the reliability of each attribute added in the model on the property price. It is in a vital importance because the interpretation of property price is wholly based on each attribute. Once it is discovered that the attribute is not significant, i.e. t-value is lower than the critical value, then the impact of such attribute on property price is no long interpretable.

Coefficient (b_i)

After the t-test proves that the independent variable is significant, coefficient b_i becomes commendable to interpret. Since the t-test is not used to measure the magnitude of the effect of the independent variables on the dependent variable, it is the function of coefficient b_i to measure such effect.

In linear regression, the coefficient of each independent variable equals to the change in dependent per unit change in the independent variable. In logistic regression, the coefficient of each independent variable equals to the percentage change in dependent per unit change in the independent variable. The coefficient can be either positive or negative, showing the either positive or negative relation between dependent variable and independent variable.

The coefficient of each attribute shows the relation with and the extent to the property price in this study. It is essential in the subsequent analysis in indicating how each attribute affects the property price.

4.5 Attributes affecting residential property price

As hedonic regression is employed in this study, it is required to include various independent variables in order to control their influence on the dependent variable, which is the residential property price. Rosen (1974) suggests that all attributes affecting the determination of market price should be taken into consideration. Chan (2002) states that in order to control the infinite number of attributes affecting the property value, selection process of such attributes is required to choose those are much appropriate and significant. It can uphold the function of model to interpret the price by desired variables.

There is no rule to restrict the number of independent variables to be included in the model, however, usually more variables will increase the complexity of the model though the predictability of the model is enhanced. Therefore, both simplicity and accuracy of model is crucial in creating the model. Therefore, in this study, several independent

variables, which are dominant factors in determining the property price along Ma On Shan Rail, are included, such as age of building, size of flat, floor level, views of property, and most important, the distance from the station to the property, the time variables in three stages and location variables to classify properties in different places.

In the followings, variables which are included in the analysis are discussed in their importance on the study.

4.5.1 Dependent variable

Price of housing unit (PRICE)

The price of housing refers to the transaction price at that time. Since the property transactions are recorded in different time period, the prices are subject to the fluctuation of the market, it is required to convert the transaction price into real price having the same time base in order to eliminate the effect of time on the price. It can be done by converting the transaction price into real price in same base. Therefore, the interpretation of the difference of price can be subject to other independent variables without any inflation and fluctuation effect. The price index classified by five classes (Table 4) from 1993 to 2005, issued by the Rating and Valuation Department is shown in *Appendix 2*.

Class	Gross Floor Area
A	smaller than 430.56 sq. ft.
B	between 430.56 sq. ft. and 752.4 sq. ft.
C	between 752.4 sq. ft. and 1076.4 sq. ft.
D	between 1076.4 sq. ft. and 1721.16 sq. ft.
E	larger than 1721.16 sq. ft.

Table 4: Definition of class in term of gross floor area in private residential property

(Sources: Rating and Valuation Department, 2006)

The property price is found in the Economic Property Research Centre (EPRC) which records most of the transaction of properties in Hong Kong registered in the Land Registry in details EPRC. It will be used in the model in million dollars.

4.5.2 Independent variables

Independent variables are used in the model in order to interpret the impact of each independent variable on the dependent variable. Apart from quantitative variables, of which value can be used directly in the model, others are dummy variables, which just have value of either one or zero. Followings present the independent variables used in this study.

Quantitative variables

Building age (AGE)

Building age refers to the difference between the date of issuing the Occupation Permit and the date of transaction of the residential property. Date of Occupation Permit, which represents the birth of building, can be obtained from the Rating and Valuation Department, while the date of transaction of the residential property can be obtained from EPRC. Usually, date of transaction recorded in EPRC refers to the signing of the Agreement for Sale and Purchase.

Building age is one of the considerable factors because when the building gets older, it will deteriorate, which will certainly affect the price of the building. Although renovation will help to restore the condition to some extent, however, generally price declines with the age increases. (Chang, 1995) (Mills, 1996)

In the model, building age will be measured in term of year, corrected to 2 decimal places.

Size of housing unit (GFA)

Size of the housing unit will depend on their Gross Floor Area (GFA)[21], which does not only include the floor space within property, but also includes the common areas. Generally, property having larger GFA should have higher price.

In the model, the floor area will be computed in term of square feet, which is obtained from EPRC.

Floor Level (FLOOR)

It is easy to notice that most of the building in Hong Kong is high rise due to limited land space. Floor level in this study refers to the floor number on which the property is situated. Basically, property situated at higher level has a higher price than that at lower floor since the property at higher level enjoys better scenery and avoids noise and air pollution from the roadside.

The floor level can be obtained through EPRC. There are a few transaction records of combined units located in different storeys in EPRC. Such transactions will be eliminated since these units cannot reveal the effect of floor level of the residential properties on their price.

[21] According to the Buildings Ordinance (Cap. 123), "gross floor area" means the floor area contained within the external walls of the building measured at each floor level (including any floor below the level of the ground, and any roof used for club purposes), together with the area of each balcony in the building, which shall be calculated from the overall dimensions of the balcony (including the thickness of the sides thereof), and the thickness of the external walls of the building. It excludes common area such as air-conditioning and mechanical room, bay windows, lift machine room, lifts and staircases pass through carparking floors, pump room, refuse chamber, transformer room and water tanks. But it includes a clubhouse,and management office.

Distance from railway station (DIST)

One of the hypotheses is to test the proximity to the station. Therefore, this independent variable is included in the model to measure the degree of impact of the station on price of residential properties.

It is difficult to estimate the movement of the residential property price because there are both advantages and disadvantages for residential properties located near to the station. Convenience will be the benefit of the proximity but it will bring pollution effect to the property, especially for KCR since it does not operate underground.

The distance of the stations to the each property development is measured from the electronic map[22]. It is measured in straight-line distance, in term of meters from the center of each property to the center of a station.

Dummy variables

Dummy variables are used for the independent variables of which there is no quantity will be taken into consideration. They just take the value of either 0 or 1, based on the conditions set for the variables.

[22] Centamap (www.centamap.com/cent/index.htm)

View

Sea view (SEA)

Sea view refers to the residential properties having the scenery of sea. Mok, Chan and Cho (1995) states that the coefficients of seaview and facing south are positively related to residential property price. Usually, people will prefer to choose property with seaview, for example facing the Victoria Harbour and the South China Sea.

In Shatin, especially in Ma On Shan, most properties of residential developments near the harbour-side enjoy the great seaview of Tolo Harbour. Those properties then should have higher value than those do not possess seaview. In this study, property having seaview takes the value of 1, if not, it takes the value of 0.

Mountain view (MOUN)

Mountain view refers to the property having a scene of mountain. Cassal and Mendelsohn (1985) find that a mountain view is one of the significant determinants of housing prices in a study of 423 homes in Seattle. Usually, mountain view gives the occupants a view of green environment, which is rarely to be found in most urban area.

In Shatin and Ma On Shan, except from facing Tolo Harbour, most properties enjoy the mountain view of Ma On Shan, located at the West, and Lion Rock which is located at the South. Green view should be much preferable than facing building forest in Hong

Kong. In this study, property having mountain view takes the value of 1, if not, it will be assigned the value of 0.

River view (RIVER)

Some buildings may enjoy the view of river, rather than usual seaview and mountain view in Hong Kong. In Shatin, there are lots of developments situated at the river promenade, facing Shing Mun River Channel. Since it is not available for all properties to enjoy the harbour view, river view is the alternative choice for people who want to live with the view of 'water'. In this study, property enjoys the river view takes the value of 1 and 0 is for the property does not have river view. It is predicted that property having river view has higher property price.

Location

Ma On Shan (MOS)

Location variable is used to classify where the property situates. It is the one of the significant variable used to test another hypothesis of then change of price gradient due to the construction of railway.

In this study, only two stations are used for comparison, which are Ma On Shan station and City One station. If the property is located near Ma On Shan station, it will take the value of 1, otherwise, 0 is assigned to property located not near to Ma On Shan station, which must be located near to City One station.

The dummy location variable is used to find the effect of location on the residential property price. If positive and significant coefficient is obtained, it means that the property price in Ma On Shan is higher than that in City One.

According to Alonso (1964), Ma On Shan is much further from Central than City One, which increase the transportation costs to Ma On Shan due to increase in distance. Then rent decreases with the increase of distance, forming the negative price gradient. Therefore, theoretically, properties near Ma On Shan station should have lower price than that near City One Station.

Period

Announcement (AN)

Date of announcement refers to the project of the construction of railway gazetted officially. If the property is transacted after the announcement period but before the construction period, it will take the value of 1 for this dummy. Otherwise, it will take the value of 0.

The corresponding period of Ma On Shan Rail is:

Mo On Shan Rail:	*1-Mar-1999*	*-*	*11-Feb-2001*

In fact, before official announcement of rail construction, there should be rumor of the construction, especially during the period of the discussion of matter in Legislative

Council. Therefore, there should be some effect on the property price. However, it is difficult to find the time of the rumor started and the extent of rumor that people realized, thus such period of rumor is eliminated.

Announcement dummy is used to find the change of overall price level in area after the announcement of construction of station. If it is positive and significant for the coefficient of announcement dummy variable, then it means that the overall price level in area is enhanced after the announcement of construction of station.

Construction (CON)

Date of construction refers to commencement of the project of the construction of railway. If the property is transacted after the construction period but before the operation, it will be assigned the value of 1 for this dummy. Otherwise, it will take the value of 0.

The period of Ma On Shan Rail is:

Mo On Shan Rail:	*12-Feb-2001* -	*31-Oct-2003*

The interpretation of construction dummy is more or less the same as that of announcement dummy. It is used to find the change of overall price level in area after the commencement of construction of station. If the coefficient is positive and significant, it indicates that the overall price level in area is enhanced after the commencement of construction of station.

Operation (OP)

Date of operation refers to the operation of railway. If the property is transacted after the operation of railway, it will take the value of 1 for this dummy. Otherwise, it will take the value of 0.

The period of Ma On Shan Rail is:

Mo On Shan Rail:	*21-Dec-2004 onward*

Operation dummy is used to find the change of overall price level in area after the commencement of construction of station. Positive and significant coefficient means that the overall price level in area is increased when the station comes into operation.

It is predicted that all the period dummy variables should have the positive effect on the price of residential property, representing the price level of property prices increases after the announcement of the construction project, commencement of the construction project and the operation of the railway.

However, to test the hypotheses, it is required to combine the independent variables together to bring out the effect of the construction of railway.

Independent variables regarding the change of price gradient

Since one of the hypotheses is to examine the impact of railway on residential property prices in different periods, it is essential to combine two independent variables into one,

in order to test the significance of the change of price gradient in different time periods. Therefore, the new independent variables, concerning the change of price impact, are introduced.

*AN*MOS*

The independent variable refers to the preference change in purchasing residential properties in area closer to the Central Business Area (CBD) and area distant from CBD during the announcement period.

According to Alonso, he states that the area, which is proximate to the center, at where all commercial activities situate, has highest bid-rent (Alonso, 1964). Figure 19 shows the average rent of grade A office in Hong Kong in 2005, which shows that offices in Central rents much higher than other areas. Therefore, in this study, Central is regarded as CBD in Hong Kong.

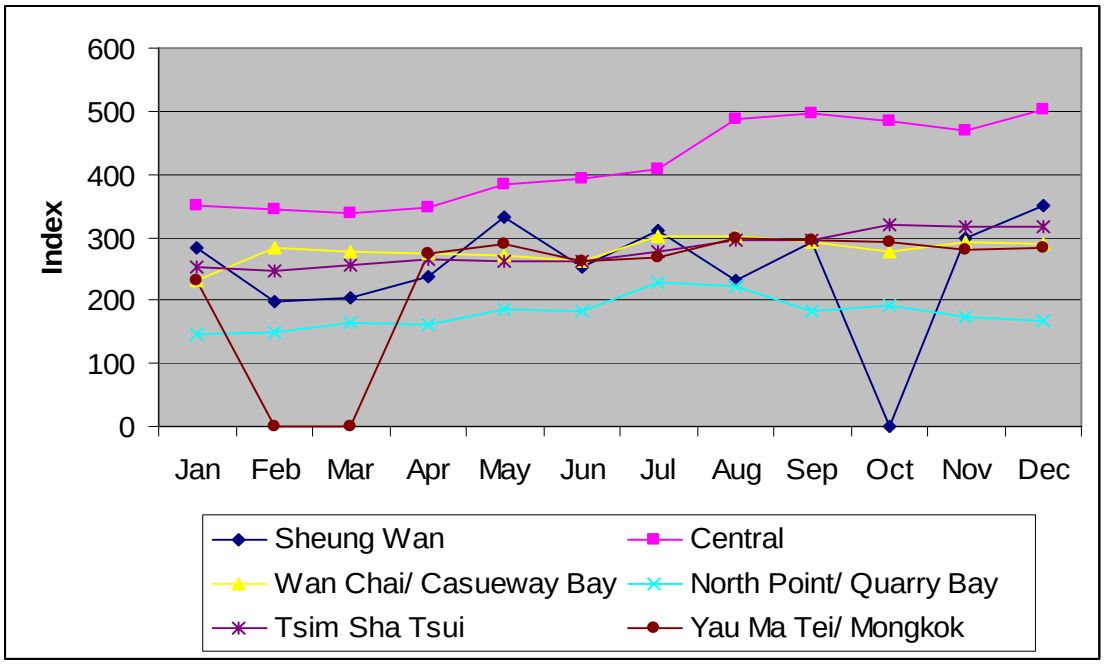


Figure 19: Private office - average rents in grade A office in 2005

(Source: Rating and Valuation Department)

Once there is a change of the independent variable which is significant, it shows that there is preference change in buying residential properties in these two areas. If the independent variable is proved to be positive and significant, then the preference change of purchasing properties increases. That means the difference of property prices in two areas increases and thus increases the slope of price gradient.

*CON*MOS*

The independent variable indicates the change of preference of the property buyers in purchasing residential properties between properties closer to CBD and those distant from CBD during the construction of the railways.

The interpretation is the same as that during the announcement period. If positive significant independent variable is found, then the price gradient increases due to the difference of two areas increases.

*OP*MOS*

The independent variable stand for the change of the preference in buying the residential properties between area nearer to CBD and area far-away from CBD during the operation of the railways.

Once the positive and significant independent variable is found, then the preference in choosing properties in two areas become wider, representing the increase of the price gradient for the prices of residential properties.

Comparing these three variables with the location variable (MOS), the change of price level in Ma On Shan, relative to City One, can be observed. It is predicted that all three variables should have positive effect on the price of the residential property, indicate that the price gradient is changed. The price level of property in Ma On Shan increases, reducing the gap of price level relative to the price level of property in City One, during three periods of change, assuming that Alonso's theory is correct so that the price level in City One is greater than that in Ma On Shan.

Independent variables regarding the impact of the proximity of station

Another hypothesis required to be tested the impact of the proximity of residential properties to station on residential properties prices. In order to add the time effect to find the impact in different periods, it is necessary to create new independent variables, which are shown as follow:

*DIST*AN, DIST*CON, DIS*OP*

These independent variables are used to see the impact of proximity to the station whether they will induce the change of the price of residential properties during the periods of announcement, construction and operation. The positive value suggests that buyers prefer to choose properties distant from the station during corresponding periods because the distance increases with the increase of property price.

4.6 Regression equation

In the study, semi-logarithm regression is used as it can provide information about the percentage change in price induced by a change in the independent variables.

1st equation – price gradient

To test the hypothesis that the expected improvement of public transportation will lead to a decline in the price gradient in the region linked by the improved railway line in all three periods, the equation is constructed as follows.

$$\ln(\text{PRICE}) = b_0 + b_1\text{AGE} + b_2\text{AGE}^2 + b_3\text{GFA} + b_4\text{GFA}^2 + b_5\text{FLOOR} + b_6\text{FLOOR}^2 + b_7\text{SEA} + b_8\text{MOUN} + b_9\text{RIVER} + b_{10}\text{MOS} + b_{11}\text{AN*MOS} + b_{12}\text{CON*MOS} + b_{13}\text{OP*MOS}$$

b_0 is the constant representing the intercept. b_1 and b_2 are the coefficients of the age of building to be estimated. Square term is added in order to make provision for its non-linear marginal effect. The coefficient, b_1, is expected to show negative as it is generally believed that older the flat, lower the price. However, the diminishing or increasing effect of coefficient, b_2, is unable to predict at this stage.

b_3 and b_4 are coefficient governing the gross floor area of the property. It is expected that b_3 is positive as larger the flat, usually, higher the price. Similarly, b_4 is uncertain. However, the generality may not come into the same case. Due to the economic downturn in 1997, the unemployment rate is high, resulting in lower household income. Therefore,

most people are not affordable to purchase large flats, which are regarded to be more expensive, at that time. The demand for large flat decreases, leading to the decrease of unit price. On the other hand, demand for small flat increases, resulting in rising unit price.

b_5 and b_6 are the coefficients of floor level to be estimated. It is expected that the sign of b_5 is positive since purchasers prefer to pay more for the property located at higher levels, in order to enjoy better sea view and better air quality.

b_7, b_8 and b_9 are the coefficients of seaview, mountain view and river view. The expected signs of these coefficients are positive. It is believed that people will be willing to pay more for the property with better views. However, it is very subjective for the preference of different people on different views.

b_{10} is the coefficient of location dummy variable. The expected sign is negative as Ma On Shan is further away from Central. Therefore, the general price in City One is higher than that in Ma On Shan.

b_{11}, b_{12}, and b_{13} are the focuses of the study. b_{11} represents the effect of provision of railway on the location preference of living on the difference in residential property price between Ma On Shan and City One, after the announcement but before the construction of the station. b_{12} and b_{13} present such effect during construction stage and operation. All these are used to examine the effect of the price gradient between Ma On Shan and City One. Positive and significant coefficients mean locational disadvantage of property situated at Ma On Shan compared to City One diminishes.

2nd equation – proximity to a station

To test the proximity of the residential properties to the station which will increase the value of the property price in all three periods, the equation for Ma On Shan Rails is shown as:

$$\ln(\text{PRICE}) = b_0 + b_1\text{AGE} + b_2\text{AGE}^2 + b_3\text{GFA} + b_4\text{GFA}^2 + b_5\text{FLOOR} + b_6\text{FLOOR}^2 + b_7\text{SEA} + b_8\text{MOUN} + b_9\text{RIVER} + b_{10}\text{AN} + b_{11}\text{AN*DIS} + b_{12}\text{CON} + b_{13}\text{CON*DIS} + b_{14}\text{OP} + b_{15}\text{OP*DIS}$$

The coefficients from b_0 to b_9 have the same interpretation mentioned in the 1st equation. b_{10}, b_{12} and b_{14} are the coefficients of announcement, construction and operation, estimating the effect of overall price level during three particular stages. It is estimated that all three coefficients are positive, reflecting the willingness of people to live near to the proposed station or constructed station. b_{11}, b_{13} and b_{15} are coefficient measuring the effect of preference of choosing property relative to the distance from the station. Positive and significant coefficients are estimated to provide that there is an increase in preference to live closer to the proposed or constructed station. It means that people will pay more for the property situated near to the station for the accessibility and convenience.

4.7 Expected sign of equation

For summary, it is predicted that, after the using regression analysis, the expected sign of independent variables is shown in Table 5 and Table 6 for 1st equation and 2nd equation respectively.

Variables	Expected sign	Meaning
AGE	Negative	If building age increases, price decreases
AGE^2	Unknown	Magnitude of the change of price due to change of age
GFA	Positive	If area of property increases, price increases
GFA^2	Unknown	Magnitude of the change of price due to change of floor area
FLOOR	Positive	If the property locates at higher floor level, price increases
$FLOOR^2$	Unknown	Magnitude of the change of price due to change of floor level
SEA	Positive	If the property has seaview, price increases
MOUN	Positive	If the property has mountain view, price increases
RIVER	Positive	If the property has river view, price increases
MOS	Negative	The difference in residential prices between City One and Ma On Shan before announcement of the construction of Ma On Shan Rail
AN*MOS	Positive	The impact of Ma On Shan Rail on the difference in residential price between City One and Sha Tin, after the announcement of the construction before the commencement of construction works
CON*MOS	Positive	The impact of Ma On Shan Rail on the difference in residential price between City One and Sha Tin, after the commencement of construction works
OP*MOS	Positive	The impact of Ma On Shan Rail on the difference in residential price between City One and Sha Tin, after the operation of Rail

Table 5: Expected sign of the independent variables in equation 1

Variables	Expected sign	Meaning
AGE	Negative	If building age increases, price decreases
AGE^2	Unknown	Magnitude of the change of price due to change of age
GFA	Positive	If area of property increases, price increases
GFA^2	Unknown	Magnitude of the change of price due to change of floor area
FLOOR	Positive	If the property locates at higher floor level, price increases
$FLOOR^2$	Unknown	Magnitude of the change of price due to change of floor level
SEA	Positive	If the property has seaview, price increases
MOUN	Positive	If the property has mountain view, price increases
RIVER	Positive	If the property has river view, price increases
DIST	Negative	Distance between station and property increases, price decreases
$DIST^2$	Unknown	Magnitude of the change of price due to change of distance between station and property increases, price decreases
AN	Positive	Overall real price level increases after the announcement of construction of Ma On Shan Rail, before the commencement of construction works
AN*DIS	Negative	The impact of Ma On Shan Rail on the difference in residential price due to distance from station, after the announcement of the construction before the commencement of construction works.
CON	Positive	Overall real price level increases after the commencement of construction works, before the operation of Ma On Shan Rail
CON*MOS	Negative	The impact of Ma On Shan Rail on the difference in

		residential price due to distance from station, after the commencement of the construction works before the operation.
OP	Positive	Overall real price level increases after the operation of Ma On Shan Rail
OP*MOS	Negative	The impact of Ma On Shan Rail on the difference in residential price due to distance from station, after the operation of Rail

Table 6: Expected sign of the independent variables in equation 2

4.8 Data Collection

4.8.1 Selection criteria

To test the hypotheses of this study, Ma On Shan and City One are selected as the subject stations to be examined. It can help to provide the room for comparison to test the change of the price gradient due to the construction of new rail. These two stations are chosen because there are a lot of properties located near the stations, thus there will be a bundle of data for analysis.

Besides, in order to study the effect of announcement, construction and operation, the properties having transaction record in all stages will be selected. It means that the date of issuing the Occupation Permit should be earlier than the date of announcement of the construction of stations. To be homogeneous, only private properties will be used for analysis.

The transaction data is collected from 1993 to 2005 because only the price index within this period is available in the Rating and Valuation Department.

Ma On Shan station

5 properties near Ma On Shan station are chosen for the analysis as shown in the Table 7.

Name of Property		Date of Occupation Permit
Bayshore Towers		1994
Ma On Shan Centre (Tower 1-4)		1994
Sunshine City	Block (A-D)	1993
	Block (E-R)	1994
The Tolo Place		1992
Villa Athena		1994

Table 7: Selected residential development in Ma On Shan

Subject to the selection criteria, these residential developments obtained the occupation permit from 1992 to 1994, while the announcement of construction of Ma On Shan Rail is in 1999. Besides, they are all private residential developments near Ma On Shan Station.

City One station

2 properties near to City One station are selected for the analysis. They are shown in Table 8.

Name of Property		**Date of Occupation Permit**
City One	Block (1-4, 7-14)	1981
	Block (5-6)	1980
	Block (15-23)	1982
	Block (24-26, 46-52)	1986
	Block (27-28, 37-45)	1985
	Block (29-33)	1983
	Block (34-36)	1987
Belair Gardens	Admiralty Heights, Beverley Heights, Carmel Heights, Dominion Heights, Estoril Heights, Fontana Heights, Grenville Heights, Hoover Heights	1982
	Imperial Heights, Jade Heights, Manhattan Heights, Nelly Heights	1987
	Kinston Heights, Lincoln Heights	1985

Table 8: Selected residential development in City One

Although there are only two private residential developments situate near City One station, there are numerous blocks in each development and all of them obtained the Occupation Permit before 1999.

4.8.2 Source of data

It is feasible to obtain the transaction records of the properties from EPRC, which includes the price of transaction (PRICE), date of transaction which is used to determine the age of building (AGE), the floor level (FLOOR) and floor area (GFA) of the properties.

From Rating and Valuation Department, it is able to find the date of occupation permit of the target buildings to compute the age of buildings (AGE), and also the price index of private domestic, which help to eliminate the effect of inflation and price fluctuation.

In order to find, the distance of station (DIST), whether properties have seaview (SEA), mountain view (MOUN) and river view (RIVER), there are no official data and so it is necessary to find through the map, including OZP and electronic map.

Chapter 5 Empirical results, analysis and discussion

5.1 Introduction

In this chapter, the data collected from EPRC in seven residential developments in both Ma On Shan and City One is put into the equations for analysis. By using Ordinary Least Square, a mathematical technique which tries to find a function which closely approximates the data, empirical results can be found conveniently through software, called EVIEW3, to generate the results in computer automatically.

After the empirical results are obtained, the significance of the result is observed first. The significance of models is interpreted in terms of R-squared and adjusted R-squared, the significance of independent variables by F-statistics and t-statistics.

Then, the statistics are analyzed individually, including the significance of each coefficients, the effect of each independent variables on the price of the residential properties and the adverse result from the prediction made in *Chapter 4*.

Finally, the price gradient and impact of proximity to a station on price are discussed in detail, in order to test the significance of the hypotheses.

5.2 Empirical results

The empirical results of equation 1 and equation 2 are shown in Table 9 and Table 10.

Equation 1 – price gradient

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	-0.031680	0.001037	-30.56385	0.0000
AGE^2	0.001137	3.58E-05	31.78675	0.0000
GFA	0.002765	1.82E-05	152.0244	0.0000
GFA^2	-7.98E-07	1.14E-08	-69.85400	0.0000
FLOOR	0.007700	0.000353	21.79793	0.0000
FLOOR^2	-0.000114	9.32E-06	-12.25795	0.0000
SEA	0.035615	0.003118	11.42106	0.0000
MOUN	-0.017497	0.002555	-6.849317	0.0000
RIVER	0.007942	0.003126	2.540407	0.0111
MOS	0.016505	0.006039	2.732970	0.0063
AN*MOS	0.053026	0.004900	10.82099	0.0000
CONS*MOS	0.066973	0.005431	12.33210	0.0000
OP*MOS	0.163066	0.007292	22.36185	0.0000
C	-0.713118	0.010379	-68.70563	0.0000

Dependent Variable	ln (PRICE)
Method	Least Squares
Included observations	32,136
R-squared	0.843506
Adjusted R-squared	0.843442

Standard error of regression	0.162429
F-statistic	13,318.29
Prob (F-statistic)	0.000000

Table 9: Empirical result of equation 1

Equation 2 – proximity to a station

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGE	-0.038111	0.000745	-51.15694	0.0000
AGE^2	0.000903	3.45E-05	26.19817	0.0000
GFA	0.002594	1.83E-05	141.8936	0.0000
GFA^2	-7.22E-07	1.13E-08	-63.63137	0.0000
FLOOR	0.008314	0.000343	24.23631	0.0000
FLOOR^2	-0.000129	9.06E-06	-14.19899	0.0000
DIST	-0.000379	2.41E-05	-15.74195	0.0000
DIST^2	8.93E-07	2.87E-08	31.11340	0.0000
SEA	0.035742	0.003006	11.89129	0.0000
MOUN	-0.016916	0.002460	-6.875352	0.0000
RIVER	0.008235	0.003215	2.590451	0.0000
AN	0.118477	0.006354	18.64646	0.0000
AN*DIST	-0.000191	1.50E-05	-12.69969	0.0000
CONS	0.178555	0.006118	29.18404	0.0000
CONS*DIST	-0.000232	1.49E-05	-15.57598	0.0000
OP	0.288193	0.008558	33.67575	0.0000
OP*DIST	-0.000308	2.16E-05	-9.645892	0.0000
C	-0.593144	0.008881	-66.78590	0.0000

Dependent Variable	ln (PRICE)
Method	Least Squares
Included observations	32,136
R-squared	0.852829
Adjusted R-squared	0.852752
Standard error of regression	0.157526
F-statistic	10948.15
Prob (F-statistic)	0.000000

Table 10: Empirical result of equation 2

In the empirical result of equation 1, R-squared and adjusted R-squared are found to be about 0.84, means that 84% of the change of price of residential properties is subjected to the change in the independent variables. It is satisfactory to obtain adjusted R-squared to be more than 80%. The empirical result, therefore, is significant and reliable for interpretation.

In the examination of F-statistics of the equation 1, the probability of the statistical coefficients to be zero is 0%. Therefore, the empirical result derived from the model is statistically significant and the probability of all coefficients getting the value of 0 is very low. In studying the t-statistics, apart from the river view, which is significant in 5% level means that it is 95% of confidence that the coefficient is non-zero, all the other independent variables are significant in 1% level, indicating that the probability of the coefficient equals to zero is only 1%. In general, the model for equation 1 is very significant for the independent variables to interpret the change of price of residential properties.

In the empirical result derived from equation 2, both R-squared and adjusted R-squared come up with the satisfactory result of 0.85, which is better than the model of equation 1, and has more than 85% of the change of price of residential properties being able to be interpreted by the change in the independent variables. This empirical result is significant and trustworthy.

Same as equation 1, the probability of F-statistics is zero, indicating the empirical result is statistically significant and there is rare chance of all coefficients equal to zero. All the independent variables show the significant result at 1% confidence level.

Therefore, both models give out the satisfactory result without any considerable adverse setback. The effect of each independent variable on the price of properties is analyzed in the following.

5.3 Analysis of empirical results

The impact of each independent variable is different, in both direction and extent, on the residential property price. Such direction and extent are determined by the sign and the value of coefficients respectively.

Equation 1 – price gradient

In equation 1, the focus is on variables of AN*MOS, CONS*MOS and OP*MOS, which are used to reveal the impact of price difference between City One and Ma On Shan in three different periods.

AGE

The coefficient of the age of building is about -0.03. This significant result shows that it is 99% confident for the coefficient not to be zero. The direction of the impact, which is denoted by the sign in the equation, is same as the prediction in previous chapter.

The coefficient of -0.03 indicates that when the age of building increases by a year, then the price of residential properties drops by 3%. Another coefficient of AGE^2 shows a positive coefficient, meaning the decrease in price is in reducing rate, subject to the increase of building age. It means that the effect of property price is subject to the Law of Diminishing Return.

In this case, the property price decreases in reducing rate when the age of building is getting older and older. It means that there is a greater difference in the price for building aged between 1 to 10 years, but less difference for the price of older building aged more than 10 to 20 years. The possibility of the diminishing effect is mainly due to the deceleration of the rate of physical depreciation over time.

Although the renovation of building is included, it still gives out the negative sign. There is a statement that renovation does not bring much effect on the restoration of condition and the increase of the value of building. However, the statement is false. It is because if renovation process cannot help the home owner get better price for his property in dealing with other purchasers, except for his own use so as to enjoy better living standard, it is meaningless for home owner to carry out renovation works before it is brought to the market.

Another statement is that the growth of price due to the renovation has less effect than the decline of price due to the increase of age. It is difficult to judge from this statement. However, no matter the result is, the fact is that the aging of building leads to the decline of property price in decreasing rate.

GFA

The coefficient of GFA is about 0.002. This positive and significant coefficient shows 99% confidence level that it is non-zero. It also gets the same sign as predicted. The figure indicates that the increase of GFA by one square feet causes the rise of property price in 0.2%. The rise also follows the Law of Diminishing Return. The property price increases in a decreasing rate. It is typical for this effect because lower unit price for property having larger size can attract people to purchase.

FLOOR

The positive and significant coefficient, which is recorded as 0.008, represents that the increase of floor level by a storey results in an increase of property price by 0.8%. Again, under the Law of Diminishing Return, the price increases slowly when the property is located at high level.

The rapid decreasing rate of the price of properties in lower level is due to the pollution effect, such as noise and bad air-quality coming from the road. Such unpleasant effect on the property decreases when the floor level increases. Therefore, some people are willing to pay more to avoid the undesirable product from the pollution. However, in higher level,

with limited pollution effect, the benefit left is the enjoyment of better view. A storey difference does not cause much on the view they have. Therefore, the effect of storey level for properties in high level is diminished.

SEA

Halvorsen and Palmquist (1980) mention a common error in the interpretation of the coefficients of dummy variables in semi-logarithmic regression equations. They make a new equation in interpreting the effect of dummy variables on the dependent variable. It is in form of:

$$\text{The percentage effect on dependent variable} = \exp\{bi\} - 1$$

For the dummy variable of seaview, the coefficient is about 0.03. This positive and significant dummy variable means when the property gets the seaview, it brings the percentage change of ($\exp^{0.03}$ -1), which is about 3% on the property price. The result matches the prediction before because it is conceited to live in residential property with great seaview. Also, it can give the occupant a comfortable feeling in living in this scenic environment.

MOUN

The negative and significant coefficient explains that property with mountain view causes the decrease of property price by about 1.76%[26]. It contradicts to the result predicted. The cause is due to the unpleasant view of the mountain around that area.

In Hong Kong, limited flat land results in the construction on the reclaimed land and along the hillside. Besides, the development on the hill can take the advantage of better view by staying away from the obstruction of properties along the harbour side. Therefore, properties on the peak get even higher price than those in mid-level. Because of the advantage, it causes a mass development along the hill side. Therefore, mass property developments or squatters along the hillside are always observed. Such scenery cannot attract people to spend more to buy property having mountain view.

RIVER

The price increases by 0.8%[27] for property having river view. The coincidence of the result with the prediction shows that people are willing to pay 0.8% of premium to live in residential property possessing river view.

This effect is considered to be much significant after the campaign was carried out in 2001 by the Environment Protection Department, named Shing Mun River Improvement. It works to reduce the unpleasant odors created by polluted residue in the Shing Mun

[26] (Exp $^{0.017497}$ -1)/100 = 1.76%
[27] (Exp $^{0.007942}$ -1)/100 = 0.80%

River, which drains into Tolo River. Therefore, the scheme can provide an improved environment to attract people to live near Shing Mun River.

MOS

At the beginning, it is assumed that Alonso's theory can apply in this case. When there is no railway to link up two different places, it is predicted that the general property price in City One is higher than that in Ma On Shan because City One is closer to assigned CBD, Central, forming the negative price gradient.

However, the result shows that there is positive and significant coefficient for MOS, representing the price level in Ma On Shan is higher than that in City One by 1.66%[28], which contradicts to the previous forecast.

The ground of higher price level in Ma On Shan is the quality of residential development and the environment in the vicinity. Although the age of building due to different time of construction is eliminated by adding the corresponding variable, the timing also influences other factors, such as construction method and quality of construction material.

In City One, two subjected developments were built in 1980's while five subjected developments in Ma On Shan were built in 1990's. There would be a great change in ten years, including the use of better material and construction method, resulting in higher standard of building.

[28] (Exp $^{0.016505}$ -1)/100 = 1.66%

Also the environment in the vicinity of the property also affects the price substantially. Apart from the view, better air quality and lower housing density can attract people who are much more willing to pursuit the feeling of comfort and space, similar to the study of Kain and Quigley (1970) and Wilkinson (1973). In Ma On Shan, before the announcement of the construction of Ma On Shan Rail, the density is lower than that in City One.[29]

The above judgment is reliable because the price level in Ma On Shan is higher than City One, contrasting the theory of Alonso.

In this stage, Ma On Shan is developed as a sub-centre. According to Cheung and Ma (2005), they mention that there is a large influx of young urban and professional people, who are mostly married couples having small children, to Ma On Shan in 1993, after the Sunshine City has been constructed and available to buy. They are typical middle-class people trying to live in modern lifestyles. In the absence of a pre-established community in neighborhood, most daily activities are carried out in adjacent shopping malls. Therefore, a sub-center is formed, comprising restaurants, cinemas, beauty salons, supermarkets, service agencies, and other necessary utilities in one shopping area.

*AN*MOS*

After the announcement of the construction of Ma On Shan Rail, the property price in Ma On Shan increases to the percentage difference of 5.47%[30] compared with City One. That means the gap of price level exaggerates after the date of announcement. The result goes

[29] In 1993, population in Shatin is 621,722, in which Ma On Shan occupies about one fourth. (http://www.legco.gov.hk/yr02-03/chinese/bc/bc52/papers/bc521119cb2-391-1c.pdf)
[30] (Exp $^{0.053026}$ -1)/100 = 5.47%

to the same direction of the estimation. It means that after the construction of Ma On Shan Rail is gazetted and officially publicized, the accessibility to Central is no longer a significant consideration for people to choose whether they want to live in City One and Ma On Shan. They had the perception that the railway would be in operation soon. Therefore, living far away from Central is acceptable after the public transportation is improved. Consequently, the price gradient changes and the locational disadvantage of Ma On Shan, due to the distance from Central, diminishes after the construction of Ma On Shan Rail is announced.

*CONS*MOS*

It measures the impact of price level in comparison of Ma On Shan and City One after the commencement of construction of Ma On Shan Rail. The difference of price level between two places increases to 6.93%[31]. The coincidence with the prediction indicates that after the construction was commenced, the importance of the proximity to Central is further brought down. Therefore, the effect of the improvement of public transportation is enhanced in construction period, further widen the gap between two places.

*OP*MOS*

After the operation of Ma On Shan Rail, the price level in Ma On Shan is 17.71%[32] more than that in City One. The exaggeration of price level refers to the diminishing effect of the locational disadvantage of Ma On Shan, compared with City One. As the

[31] (Exp $^{0.066973}$ -1)/100 = 6.93%
[32] (Exp $^{0.163066}$ -1)/100 = 17.71%

transportation cost and the traveling time are cut, the preference of living in remote area increases.

Equation 2 – proximity to a station

The equation 2 is used to examine the impact of distance from station on the residential property price. It is determined by the variables of AN*DIST, CONS*DIST and OP*DIST, which indicate the change of the impact on price in different stages.

AGE

If the age of building is increased by 1 year, the price of the property decreases by 3.8%, and the rate of decrease becomes slowly when the age of building becomes older.

GFA

If the gross floor area of the property is increased by 1 square feet, the price of building increases by 0.26%. The effect is diminished when the gross floor area increases. Therefore, larger flat has lower unit price than smaller flat.

FLOOR

Property located one higher storey causes the increase of property price by 0.83% and such effect is reduced after the property is in high floor.

SEA

If the properties have seaview, the property price is 3.64%[33] more than those does not possess seaview.

MOUN

Properties with mountain view has 1.71%[34] decrease in price, comparing with those do not have mountain view.

RIVER

From the result, people are willing to pay 0.83%[35] to purchase the property with river view.

All the above variables acquire the similar result in the equation 1.

DIST

This variable is to test the impact of the distance from the property to the proposed station before announcement of the construction of station. It is found that there is 0.03% increase in price for the property which is located near to the proposed station, and the rate of increase decline as the distance from the station increase. The effect of proximity to the "virtual" station, which does not exist before the announcement of the construction of railway, is not substantial.

[33] (Exp $^{0.035742}$ -1)/100 = 3.64%
[34] (Exp $^{0.016916}$ -1)/100 = 1.71%
[35] (Exp $^{0.035742}$ -1)/100 = 0.83%

In City One, the location of station is originally a nursery garden held by the Government. In Ma On Shan, the station is built overhead in the centre of Ma On Shan, connecting to Sunshine City. It is believed that the tiny positive impact is mostly come from Ma On Shan because people choose to live nearer to the center of Ma On Shan, enjoying the accessibility to the shopping centers, while such effect can be ignored in City One.

AN

It is used to measure the general price level during the announcement period of Ma On Shan Rail. The positive effect of announcement of the construction of railway brings out the increase of property price in both places by 12.56%[36]. Therefore, it can conclude that the announcement of improvement of the public transport can cause the rise of the price of residential development near the stations.

*AN*DIST*

During the announcement period, when the distance between the property and the station increases, the price decreases by 0.0191%[37]. Therefore, there is an announcement effect of construction of the station which provides the nearby property convenience and accessibility to the Central. To compete with other purchasers, they agree to pay a premium to live nearer to the station.

CONS

[36] (Exp $^{0.118477}$ -1)/100 = 12.57%
[37] (Exp $^{0.000191}$ -1)/100 = 0.0191%

During the construction of railway, it is found that the overall price level in two places increases by 19.55%[38], more than the price level in announcement period by 6.98%.Thus, it can notice that people become much more willing to pursuit convenience and better accessibility by paying more during construction period.

*CONS*DIST*

It determines the effect of proximity to a station on the property price during the construction period. As the distance from the station increase, the property price decreases by 0.0232%[39], which is more than that during announcement period. Therefore, when the station is constructed, people estimate the enhancement of accessibility by living close to the station.

Although there should be pollution effect during the construction period, the price still goes up. It is because the KCRC takes a good measure in controlling the impact of pollution to nearby property. Also people have perception that the property price rises further after the completion of the construction. The increase in demand for property near the station drives the price to rise.

[38] (Exp $^{0.178555}$ -1)/100 = 19.55%
[39] (Exp $^{0.000232}$ -1)/100 = 0.0232%

OP

When the railway comes into operation, the price level in Ma On Shan and City One rises by 33.4%[40], comparing with the price level before announcement of the construction of railway. The general price increases further by 13.85% from construction period to operation period. The impact of the improvement of public transportation after the operation of railway on the property price comes into existence due to decrease in transportation cost and traveling time to Central.

*OP*DIST*

After Ma On Shan Rail comes into operation, the price gradient, regarding the station as the center, increases further, with the decrease of price by 0.0308%[41] when the distance from the station increases by one meter. The increase of gradient is due to the willingness of people to pay more for the property situated near to the station. The further increase of percentage, comparing with that in construction period, indicates the willingness of people to choose a property that is proximity to the station.

5.4 Discussion of the result

Recalling the hypotheses of this study, it is to test that the improvement of public transportation, either in expected stage within announcement and construction period, and existing stage after the operation of railway, leads to a decline in the price gradient of areas linked up by the railway. Also, it is to test that the proximity of the residential

[40] (Exp $^{0.288193}$ -1)/100 = 33.4%
[41] (Exp $^{0.000308}$ -1)/100 = 0.0308%

property to the station, either proposed or constructed, leads to the increase of property price in all three periods. In this section, two hypotheses are tested based on the empirical result.

Hypothesis 1: Price gradient

Before there is any official announcement about the construction of Ma On Shan Rail, it is found that the overall price level of residential property in Ma On Shan, subjects to five private residential developments, is higher than that in City One, subjects to 2 private residential developments. Based on the study of Cheung and Ma (2005) and similar studies outside Hong Kong from Kain and Quigley (1970), Wilkinson (1973) and Ball (1974), the price of residential properties is not solely subjected to the distance from the CBD. There are other attributes affecting the housing choice such as the quality of the property, environment and community nearby. Therefore, Richardson (1977) mentions about the positive price gradient because proximity to the city center might well lower property values because of the deteriorating environment, exists between City One and Ma On Shan.

During the announcement period, the positive price gradient between City One and Ma On Shan becomes more positive. Neglecting the sign of the price gradient, the case following the theory of Alonso that improvement of transportation leads to decrease of the price gradient, so the locational disadvantage of remote area diminishes comparing with less remote area. People predict that there will be enhancement of public transportation, leading to the reduction of the transportation cost to Central and thus the increase of price of property in both places. The increase of price level in remote area,

which is Ma On Shan, is greater than the increase in nearer area, denoting City One because the preference to live in remote area is stronger than before and thus people are willing to pay more to purchase property in this area.

During the construction period, the impact of enhancement of public transportation becomes more influential on the price level of Ma On Shan and City One, which rises from the announcement period. The price gradient is further changed to more positive, indicating that there is much more driving up of overall price level in Ma On Shan.

Same case is applied after the railway come into operation. General price level is pushed up and price gradient become more slanting, making the locational disadvantage possessed by Ma On Shan fades out and the difference of price level between City One and Ma On Shan exaggerates.

To sum up, no matter during announcement period, construction period and operation period, the inconvenience of location further away from CBD is reduced, causing the price gradient become positively sloped. This situation of the case, which provides positive gradient, is different from the situation when constructing hypothesis, in which Alonso's theory is applied to the provision of negative price gradient. However, the general concept is the same in both cases that the locational disadvantage of remote area to assess to CBD is diminished with the improvement of public transportation. Therefore, first hypothesis cannot be refuted.

Hypothesis 2 – Proximity to a station

In the comparison of announcement period, construction period and operation period, it is found that the price of property located near to the station increases in these three periods, comparing with property distant away. The increase amplifies from announcement period to operation period, indicates the growing preference and competition in living closer to the station. After the construction of station and operation of the railway, it is apparent that there is an increase in accessibility to the station if people live closer to the station without spending more time on going to the station of public transportation. Such convenience is a factor of competition, causing the rise of property near to station. Therefore, the second hypothesis cannot be refuted too.

Chapter 6 Conclusions and recommendations

6.1 Conclusions

The aim and objectives of this study concern the impact of improvement of public transportation on the price of residential developments nearby, including the residential price gradient and the significance of proximity to station.

From the literature, it is found that generally there is negative price gradient, indicating the decline trend of price of property from the center. The improvement of public transportation will reduce the transportation cost and boost the price of residential properties. Thus, it will lead to the decrease of the price gradient, indicating the diminishing effect of locational disadvantage of remote area. It is seen that the aim that there is an impact on property price owing to the improvement of public transportation is supported by literature.

Ma On Shan Rail is the target of study. As the railway was announced to operate on March 1999, there should be an anticipation of the enhancement of public transportation in Ma On Shan District. Such anticipation should be enhanced during construction and operation. Therefore, following the past literatures, an opportunity is given to test the hypotheses that the improvement of public transportation will lead to a decline in the price gradient for areas linking by the railway, and the proximity to the station will increase the residential property price. The impacts are examined in three different periods - announcement period, construction period and operation period.

Hedonic pricing model was adopted in this study to find the impact of the introduction of Ma On Shan Rail to the properties located along the railway. It is because the hedonic price model provides a means to eliminate the effect of other attributes which varies the property price in different extents. In order to eliminate other possible effect on the property price, independent variables are added into the model, such as age of building, floor level, gross floor area and the view, so that the heterogeneous characteristics of property can be controlled.

In selection of samples, seven private residential developments near two stations along the Ma On Shan Rail were used. Two properties are selected from City One which is nearer to Central, and 5 properties from Ma On Shan, regarded as remote area.

To investigate the change in different periods, samples are compared according to the date of transaction and their location. Location variable is added to classify whether the property is near Ma On Shan station or City One station, while the time variables are added to classify the transaction into four periods, namely pre-announcement period, announcement period, construction period and operation period. On the other hand, to investigate the proximity effect, time variables and variable of distance, which is used to measure the effect of distance from the station, are added.

From the empirical result, it was found that there is positive effect on the price gradient and the proximity to station. Also, the effect occurs in all three defined periods.

Upon the change of the price gradient between Ma On Shan and City One, it is noticed that the price gradient becomes more and more positively sloped from the announcement

period to the operation period. The decline of the price gradient indicates that the effect of the distance from the CBD is diminished throughout the periods. However, the situation of the study is different to that in literature. In most cases, such as Chau and Ng (1998), area far away from the CBD should have lower price level than area nearer to the CBD, following the rule of Alonso in negative price gradient. In this study, however, it is found that Ma On Shan had higher price level before the announcement period. The difference in price level expands throughout the construction of Ma On Shan Rail. The positive price gradient between Ma On Shan and City One is formed. Nevertheless, the first hypothesis cannot be refuted since the decline of the price gradient indicates the shorter traveling time and the lower transportation cost. It is the outcome showing the impact of improvement of public transportation on the residential properties.

Furthermore, it is found that the proximity effect increases after there is improvement in public transportation. There is dramatic change of percentage of the property price subjected to the distance from the station. People are willing to pay more and more to live nearer to the station from pre-announcement period to operation period. The result indicates that the convenience and better accessibility brought by the improvement of public transportation encourage people to live nearer to the station. Therefore, the second hypothesis cannot be refuted and there is an impact of the location of station on the people preference in choosing the residential properties.

6.2 Limitations of the study

There are limitations in constructing the model. Several variables, such as age, size, floor level and view are added, and they are all found to be significant, however, since property is heterogeneous in nature, it is impossible to include all the attributes into the model. It is because it is difficult to identify all the attributes affecting the property price. Even if identification is made, the model will become complicated. Besides, some variables are difficult to measure. For example, the definition of quality of building is ambiguous without a unique meaning because there are various standards to define it. Another example is environment. It is subjective opinion of people, either they like to live in peace remote area or noisy urban area. Other examples are climate, economic, developer and contractor. These kinds of variables are difficult to determine and therefore, significant and related variables are chosen to use in this study.

In this study, it is to study the impact on private residential developments in Ma On Shan District. Only private residential developments are included in order to have homogeneous samples. Therefore, other properties under home ownership scheme, private sector participation scheme and sandwich housing scheme are not taken into consideration to generate more comprehensive analysis.

Along the railway, out of nine stations, only City One station and Ma On Shan station are selected. It is because there are few transaction records in other stations. Even if the transaction data is abundant, they do not cover all subjected periods, including pre-announcement period. As Ma On Shan district is regarded as the extension of Shatin to become a new town, the development started intensively after the announcement or

construction of railway. It is the strategy of developers to market the development which are going to be benefited by the new railway. Therefore, to be homogeneous and indicate the change in all periods, developments obtaining the Occupation Permit before the announcement of the construction of railway and are assembled near City One station and Ma On Shan station, are chosen. It lead to shortcoming that only the price gradient between two stations is found, but it cannot examine the significance of Ma On Shan Rail by examining its effect on all residential developments along the railway.

6.3 Recommendations for further research

Due to the limitation of the research, not only private residential developments, all other developments may show the impact of improvement of public transportation on property price. Therefore, properties development under home ownership scheme, private sector participation scheme and sandwich housing scheme can be included in the research to investigate the overall impact of Ma On Shan Rail on property price. Therefore, more comprehensive research and analysis can be carried out. Besides, additional samples may be available in other stations, so that the study can be more completed along Ma On Shan Rail.

Furthermore, all the transactions included in the study comprises of housing in primary market and secondary market. Therefore, the effect of public transportation enhancement can be studied more specific in primary market or secondary market.

Apart from studying the residential property price along the Ma On Shan Rail, other sectors can also be examined. For example, retail service can be studied in change of rent,

change of tenant mix or change of positioning. Impact on other public transportation or strategy of developer before and after the construction of railway can also be inspected.

As it is long time from the announcement period, it is difficult to study the rumor phase. Therefore, study on the effect of improvement of public transportation before officially announced can be carried out, such as Shatin to Central Link, Island Line Extensions, Northern Link and Port Rail Line. The impact can be studied through different sectors such as residential market, commercial market and retail market.

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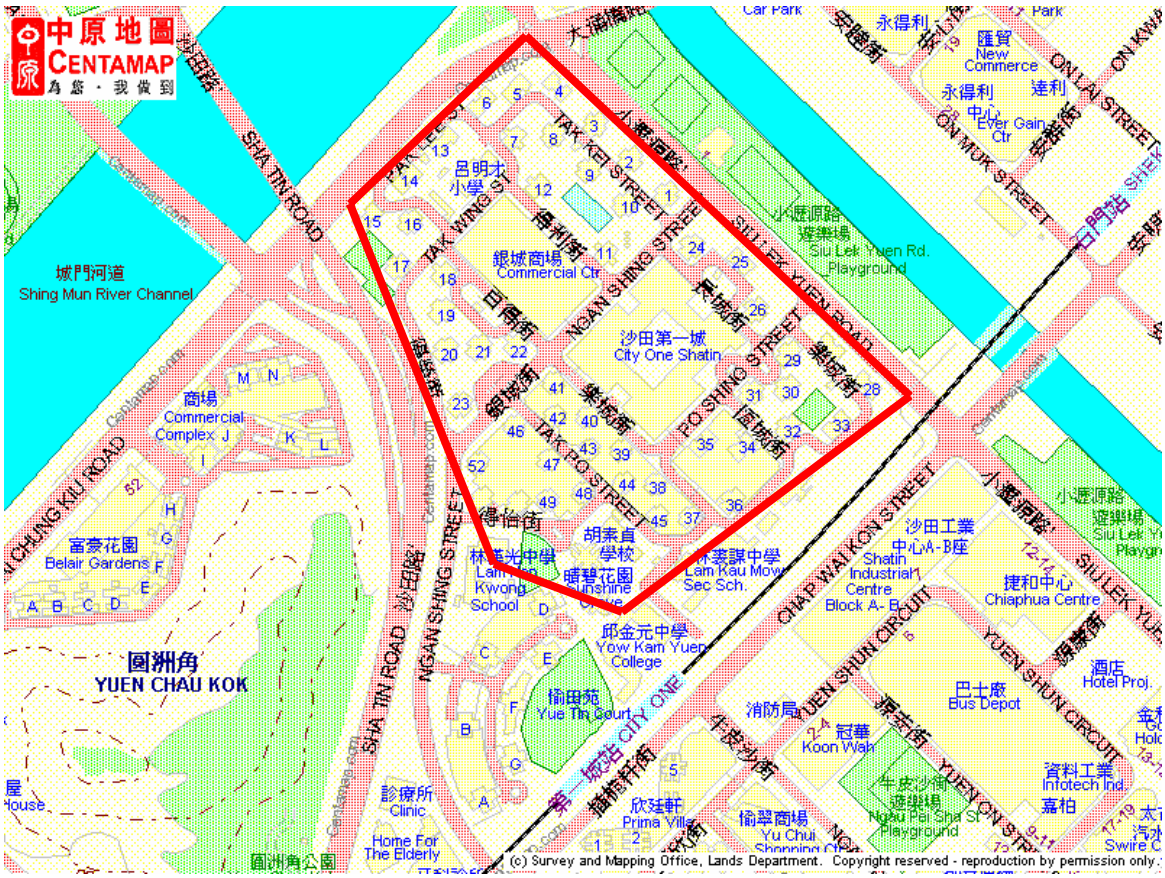
Appendices

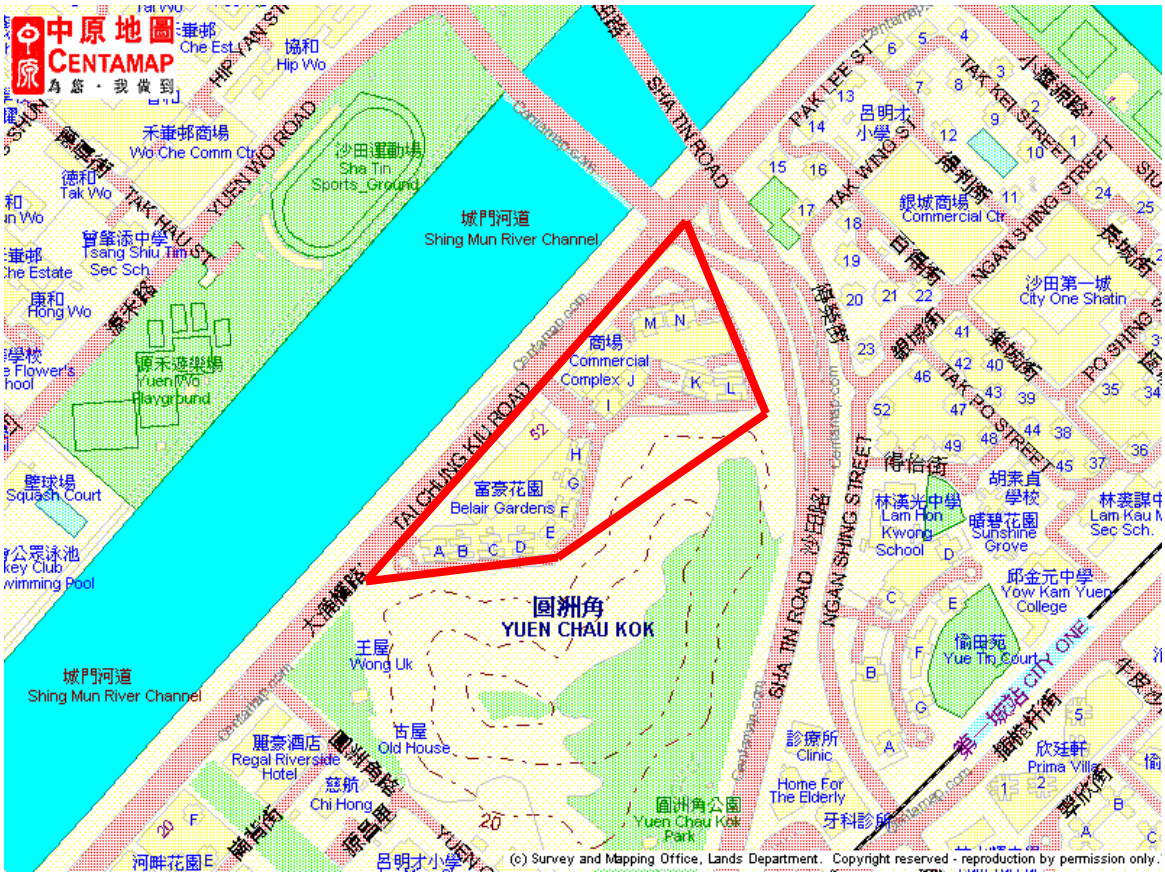
Appendix 1 – Location plan of selected residential developments

City One

City One



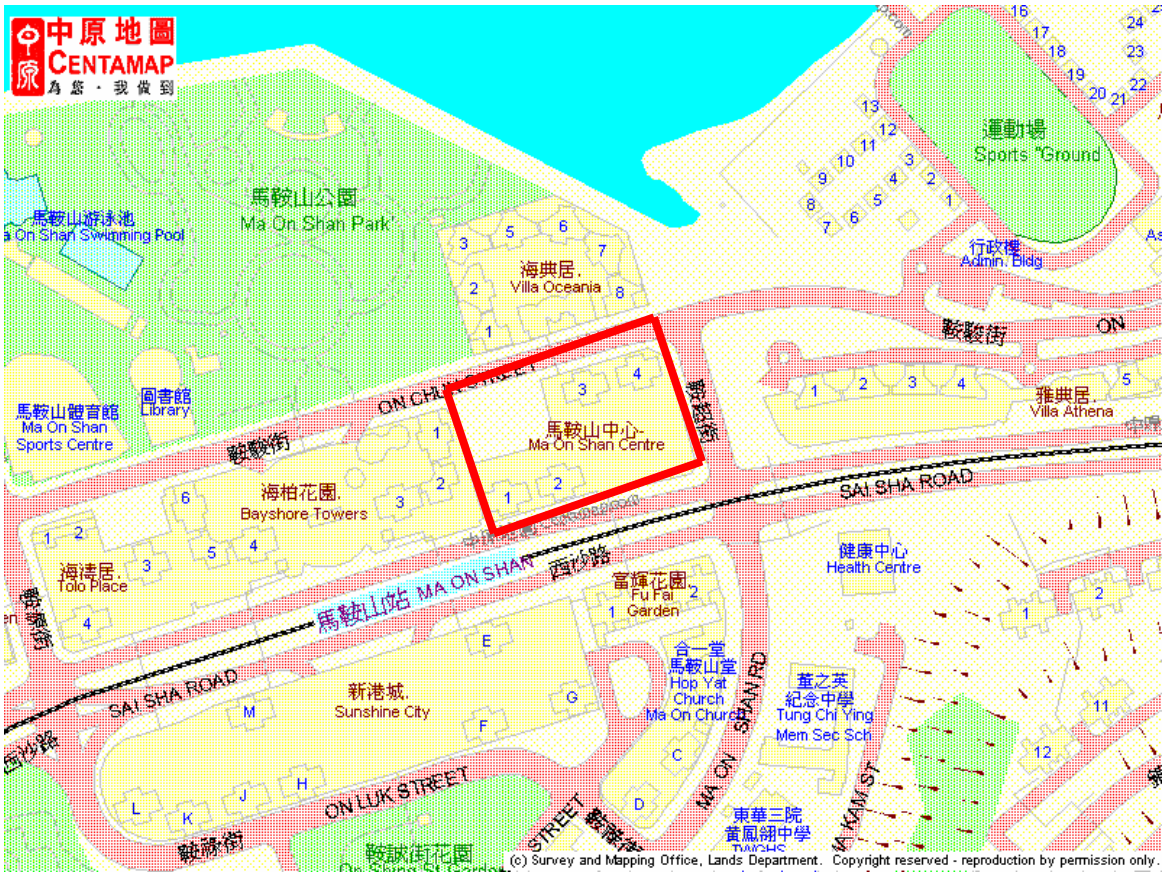
Belair Gardens



Ma On Shan

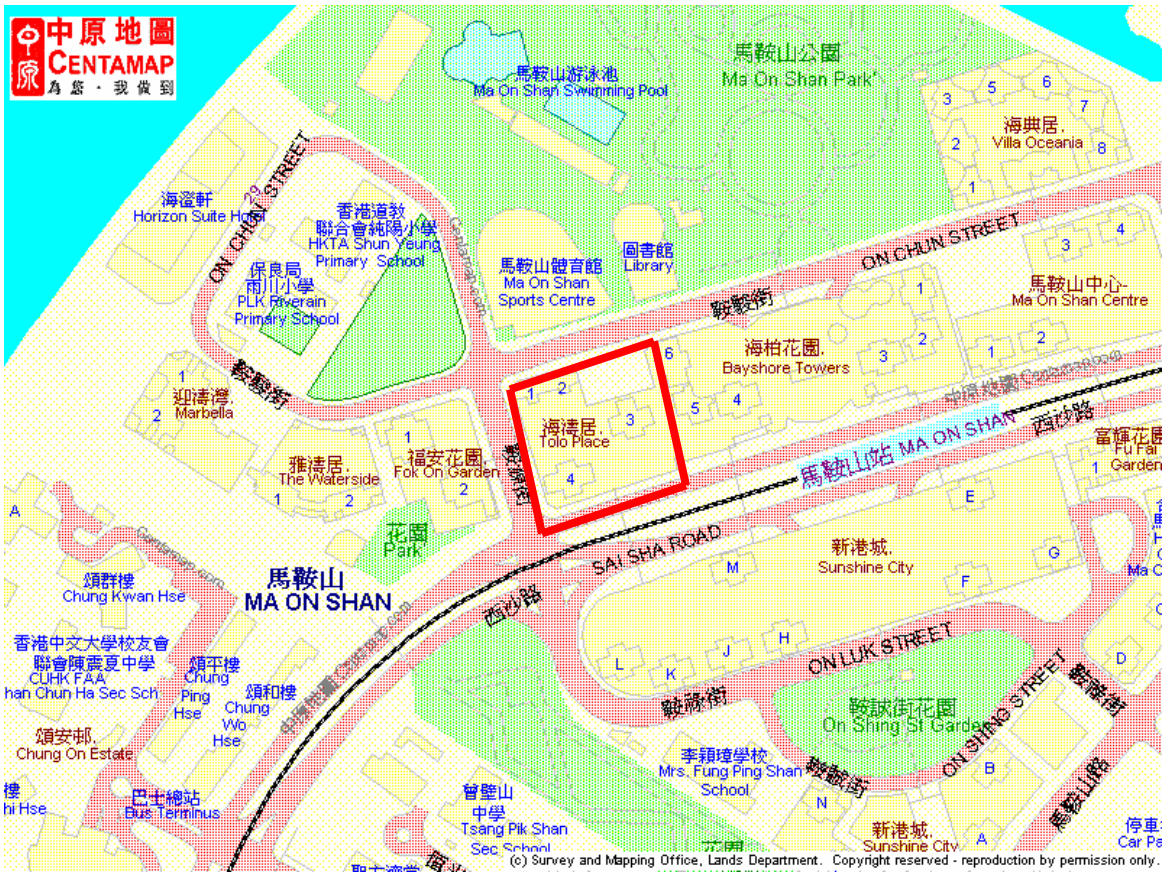
Bayshore Towers

Ma On Shan Center

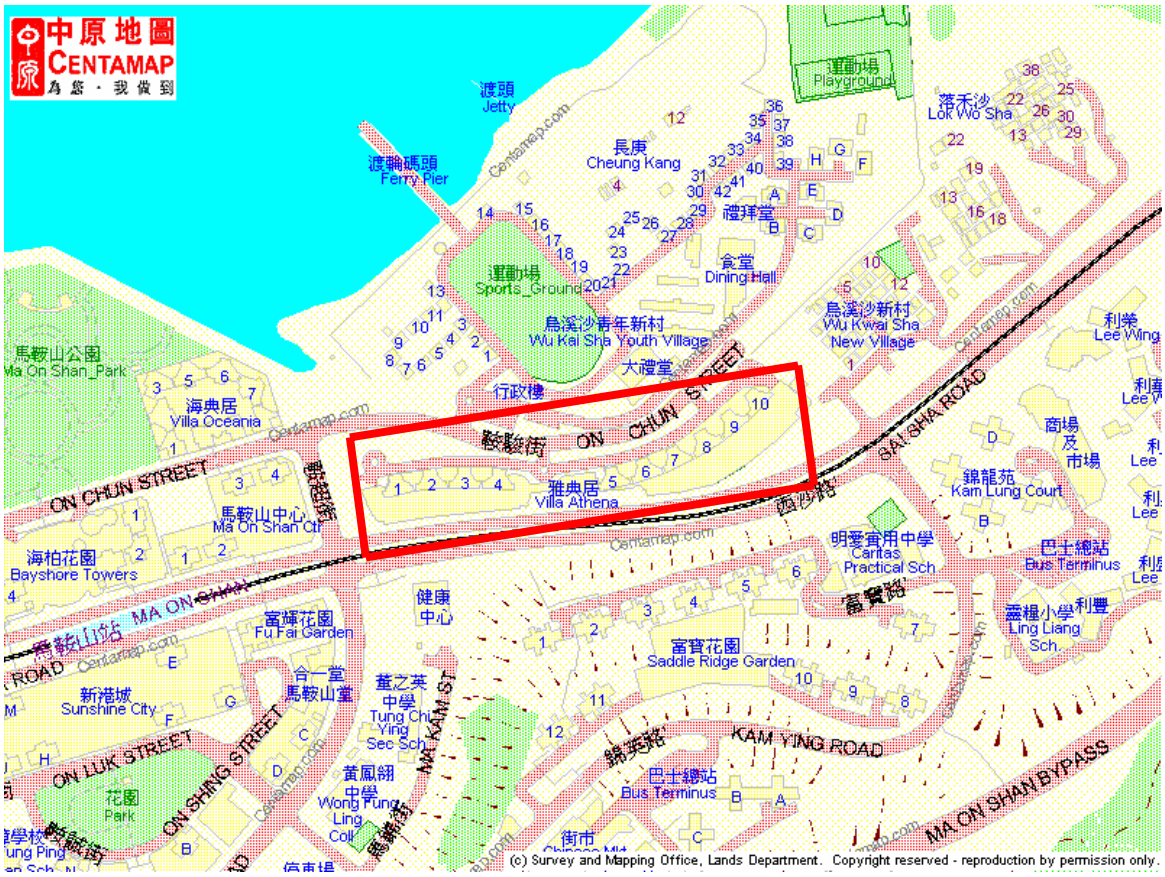


Sunshine City

The Tolo Place



Villa Athena



Appendix 2 – Price indices of private domestics by class from 1993 to 2005

Year	Month	Class				
		A	B	C	D	E
1993	Jan	90.4	81.3	80.7	74.2	58.1
	Feb	90.5	82.6	81.3	74.9	62.2
	Mar	90.2	83.9	81.9	75.4	64.6
	Apr	92.5	85.4	83.7	76.8	66.2
	May	95.9	88.6	85.9	80.5	72.3
	Jun	98.3	94	91.4	86.9	76.3
	Jul	100.1	98	97.6	90.6	79.2
	Aug	101	97.9	96.1	91.1	76.8
	Sep	100.7	96.2	95.5	88.7	79
	Oct	97.8	94.4	95.6	90	83.2
	Nov	99.5	97.3	97.5	92.9	85.3
	Dec	102.2	100.2	100.3	99	92.4
1994	Jan	106.3	108.6	110.2	106.6	104.0
	Feb	109.9	112.9	113.3	111.1	108.3
	Mar	114.5	122.9	123.2	119.7	120.2
	Apr	116.9	117.7	123.8	124.3	120.5
	May	114.8	115.8	123.0	115.4	116.3
	Jun	114.1	116.7	122.8	119.0	112.8
	Jul	113.5	113.0	118.6	116.7	112.1
	Aug	116.7	117.4	122.7	123.5	115.6
	Sep	116.1	115.6	121.1	117.0	118.0
	Oct	116.5	116.7	118.4	119.7	115.1
	Nov	115.7	114.1	117.6	117.7	116.4
	Dec	110.2	108.9	114.5	112.2	118.4

Year	Month	Class				
		A	B	C	D	E
1995	Jan	109.9	109.9	110.8	111.0	111.3
	Feb	113.9	112.4	109.8	102.3	(99.5)
	Mar	114.2	112.9	112.7	108.9	113.1
	Apr	114.7	111.2	112.0	109.1	113.6
	May	110.8	109.4	111.5	109.8	103.5
	Jun	110.4	106.0	108.8	108.1	108.7
	Jul	108.5	105.0	104.9	103.2	104.3
	Aug	108.0	102.4	105.4	102.1	101.3
	Sep	104.5	99.6	99.9	98.9	96.1
	Oct	103.5	99.1	98.9	96.6	96.2
	Nov	105.4	102.0	100.6	99.7	99.3
	Dec	106.3	102.7	102.9	99.2	94.0
1996	Jan	106.9	104.7	102.0	100.2	102.5
	Feb	109.1	108.6	107.2	106.4	104.5
	Mar	112.2	114.5	109.2	107.6	109.9
	Apr	112.1	112.4	110.9	109.6	113.4
	May	113.3	113.5	114.2	111.7	116.8
	Jun	114.7	114.8	117.1	114.8	116.3
	Jul	115.4	114.0	114.2	115.0	115.8
	Aug	116.8	118.5	116.4	113.9	115.6
	Sep	119.0	117.7	117.0	118.7	116.5
	Oct	122.4	123.3	124.0	125.7	124.1
	Nov	127.1	128.2	129.1	130.0	135.7
	Dec	132.5	135.2	136.5	139.2	140.2

( ) Indicates fewer than 20 transactions

Year	Month	Class				
		A	B	C	D	E
1997	Jan	137.9	143.6	148.8	156.1	160.9
	Feb	151.1	154.6	160.6	163.4	164.2
	Mar	160.6	162.4	167.1	163.1	166.4
	Apr	154.5	157.8	162.1	160.6	159.5
	May	169.5	173.7	175.3	175.0	184.6
	Jun	171.0	171.0	177.7	176.1	179.6
	Jul	165.1	166.7	174.4	171.9	180.0
	Aug	168.8	170.5	180.2	174.2	185.0
	Sep	170.2	169.1	174.3	174.4	173.5
	Oct	171.1	172.1	178.7	178.2	198.2
	Nov	161.2	157.0	166.9	173.1	166.4
	Dec	155.4	153.4	160.0	156.1	156.3
1998	Jan	145.2	141.0	148.9	147.4	142.2
	Feb	138.5	134.6	136.2	138.5	135.7
	Mar	140.4	137.9	137.4	137.6	128.1
	Apr	135.5	133.4	136.3	131.3	126.6
	May	129.4	126.2	128.2	125.2	126.8
	Jun	114.0	111.7	110.0	111.0	118.0
	Jul	110.2	105.9	110.6	105.9	104.3
	Aug	106.3	104.3	102.1	99.1	98.5
	Sep	100.4	96.8	99.6	102.1	92.8
	Oct	96.6	95.1	95.2	94.1	96.3
	Nov	100.7	100.4	99.1	101.2	94.4
	Dec	105.0	105.0	103.5	100.2	104.5

Year	Month	Class				
		A	B	C	D	E
1999	Jan	103.9	103.9	105.0	102.0	98.2
	Feb	103.0	101.7	102.8	98.0	97.5
	Mar	102.4	102.2	99.1	99.6	94.8
	Apr	102.7	101.8	101.4	100.5	101.7
	May	103.1	103.1	102.6	100.7	101.8
	Jun	103.3	101.5	101.8	103.4	102.2
	Jul	101.8	101.4	100.0	105.3	100.2
	Aug	99.3	101.3	100.5	100.8	103.2
	Sep	96.8	97.0	98.0	99.7	97.2
	Oct	95.5	95.7	96.5	97.6	99.1
	Nov	93.2	94.5	95.1	95.1	105.2
	Dec	94.9	95.8	97.1	97.3	99.0
2000	Jan	96.6	97.5	98.4	98.8	107.4
	Feb	96.2	98.0	98.2	99.7	102.0
	Mar	93.2	95.8	97.6	99.7	102.3
	Apr	92.4	93.8	96.8	99.2	101.2
	May	89.0	89.9	92.1	99.1	96.9
	Jun	84.5	85.6	89.5	91.5	95.3
	Jul	86.0	86.2	88.0	90.3	92.4
	Aug	86.0	87.1	88.1	91.2	95.7
	Sep	87.4	88.0	88.6	92.3	98.0
	Oct	86.5	86.4	88.1	91.2	98.4
	Nov	81.3	84.1	85.5	89.3	98.2
	Dec	80.2	81.6	83.7	88.5	96.5

Year	Month	Class				
		A	B	C	D	E
2001	Jan	78.9	80.5	83.4	88.4	94.6
	Feb	78.7	80.0	83.0	85.3	91.3
	Mar	80.5	82.3	83.9	87.2	88.7
	Apr	81.9	81.4	84.6	87.5	90.0
	May	79.0	80.5	83.8	83.4	88.5
	Jun	78.7	81.3	85.3	82.5	88.8
	Jul	78.7	80.5	81.8	83.0	88.7
	Aug	76.7	79.1	78.8	83.8	89.9
	Sep	75.9	77.5	78.1	81.1	87.5
	Oct	72.7	74.4	75.7	78.8	80.9
	Nov	71.9	74.0	75.2	78.5	82.1
	Dec	72.3	74.1	75.5	78.4	82.5
2002	Jan	72.6	74.5	75.7	78.2	84.0
	Feb	73.4	73.7	74.3	78.2	86.2
	Mar	71.9	73.6	74.3	78.0	85.2
	Apr	70.4	72.7	74.3	77.9	84.9
	May	69.4	73.7	73.9	77.7	84.4
	Jun	69.4	72.6	74.3	77.3	83.2
	Jul	69.0	71.4	72.3	77.2	80.8
	Aug	66.9	68.1	70.6	76.4	79.2
	Sep	64.1	67.5	68.4	75.3	76.9
	Oct	64.0	64.7	68.7	75.1	77.2
	Nov	62.9	64.9	68.8	75.1	79.4
	Dec	62.7	64.9	67.0	73.1	80.5

Year	Month	Class				
		A	B	C	D	E
2003	Jan	61.5	63.4	67.2	72.6	79.9
	Feb	61.0	63.8	66.5	70.7	75.7
	Mar	60.0	60.6	64.3	68.8	73.9
	Apr	59.4	59.8	64.1	67.7	72.6
	May	58.2	59.3	63.3	67.6	71.2
	Jun	57.3	59.2	62.6	66.6	71.7
	Jul	56.6	58.3	61.1	64.9	73.4
	Aug	56.8	58.5	60.8	66.2	73.7
	Sep	59.1	60.2	65.5	70.5	75.1
	Oct	61.3	62.5	68.6	73.8	80.4
	Nov	62.1	63.6	69.5	74.3	81.7
	Dec	63.2	64.4	70.0	79.1	85.6
2004	Jan	66.4	68.8	75.4	81.1	92.2
	Feb	69.2	72.4	81.5	86.9	96.2
	Mar	72.9	77.1	89.0	96.0	102.9
	Apr	73.4	79.2	89.3	98.1	101.7
	May	72.8	76.4	87.4	96.0	103.1
	Jun	69.7	73.9	83.2	92.1	106.3
	Jul	70.0	74.0	83.9	93.4	103.5
	Aug	73.1	76.4	87.8	93.3	104.1
	Sep	74.7	80.5	91.2	100.3	113.8
	Oct	77.6	83.2	95.8	106.0	117.1
	Nov	75.9	81.6	95.1	106.8	117.3
	Dec	76.4	82.6	94.1	107.9	120.8

Year	Month	Class				
		A	B	C	D	E
2005	Jan	78.4	80.5	85.5	89.8	91.2
	Feb	78.3	80.9	85.7	91.9	92.4
	Mar	80.1	81.6	86.6	94.4	90.7
	Apr	81.1	83.2	89.4	92.2	93.3
	May	83.1	83.9	90.3	91.9	95.8
	Jun	83.3	84.3	91.9	92.1	97.6
	Jul	83.3	86.6	91.6	96.5	97.9
	Aug	84.2	86.3	91.0	96.8	101.6
	Sep	84.8	88.1	91.4	96.5	105.3
	Oct	86.6	89.3	95.1	99.1	101.2
	Nov	86.5	88.8	95.5	98.3	101.2
	Dec	78.4	80.5	85.5	89.8	91.2